Coeur d'Alene Tribe
Fisheries Program

Implementation of Fisheries Enhancement Opportunities on the Coeur d'Alene Reservation

2002 Annual Report

Coeur d'Alene Tribe Department of Natural Resources
Fisheries Program
401 Annie Antelope Rd.
Plummer, ID 83851-0408

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INTRODUCTION

Background

Historically, the Coeur d'Alene Indian Tribe depended on runs of anadromous salmon and steelhead along the Spokane River and Hangman Creek, as well as resident and adfluvial forms of trout and char in Coeur d'Alene Lake, for survival. Dams constructed in the early 1900s on the Spokane River in the City of Spokane and at Little Falls (further downstream) were the first dams that initially cut-off the anadromous fish runs from the Coeur d'Alene Tribe. These fisheries were further removed by the construction of Chief Joseph and Grand Coulee Dams on the Columbia River. Together, these actions forced the Tribe to rely solely on the resident fish resources of Coeur d'Alene Lake (Staff Communication).

The Coeur d'Alene Tribe is estimated to have historically harvested around 42,000 westslope cutthroat trout (*Oncorhynchus clarki*) per year (Scholz et al. 1985). In 1967, Mallet (1969) reported that 3,329 cutthroat were harvested from the St. Joe River, and a catch of 887 was reported from Coeur d'Alene Lake. This catch is far less than the 42,000 fish per year the tribe harvested historically. Today, only limited opportunities exist to harvest cutthroat trout in the Coeur d'Alene Basin.

The declines in native salmonid fish populations, particularly cutthroat and bull trout (*Salvelinus confluentus*), in the Coeur d' Alene basin have been the focus of study by the Coeur d' Alene Tribe's Fisheries and Water Resources programs since 1990. It appears that there are a number of factors contributing to the decline of resident salmonid stocks within Coeur d'Alene Lake and its tributaries (Ellis 1932; Oien 1957; Mallet 1969; Scholz et. al. 1985, Lillengreen et. al. 1993). These factors include: construction of Post Falls Dam in 1906; major changes in land cover types, agricultural activities and introduction of exotic fish species.

Over 100 years of mining activities in the Coeur d'Alene River drainage have had devastating effects on the quality of the water in the Coeur d'Alene River and Coeur d'Alene Lake. Effluents from tailings and mining waste have contributed vast quantities of trace heavy metals to the system. Poor agricultural and forest practices have also contributed to the degradation of water quality and habitat suitability for resident salmonids. Increased sediment loads from agricultural runoff and recent and recovering clearcuts, and increases in water temperature due to riparian canopy removal may be two of the most important problems currently affecting westslope cutthroat trout. Increases in water temperature have reduced the range of resident salmonids to a fraction of its historic extent. Within this new range, sediment has reduced the quality of both spawning and rearing habitats. Historically, municipal waste contributed large quantities of phosphates and nitrogen that accelerated the eutrophication process in Coeur d'Alene Lake. However, over the last 25 years work has been completed to reduce the annual load of these materials. Wastewater treatment facilities have been established near all major municipalities in and around the basin.

Species interactions with introduced exotics as well as native species are also acting to limit cutthroat trout populations. Two mechanisms are at work: interspecific competition, and species replacement. Competition occurs when two species utilize common resources, the supply of which is short; or if the resources are not in short supply, they harm each other in the process of seeking these resources. Replacement occurs when some environmental or anthropogenic change (e.g., habitat degradation, fishing pressure, etc.) causes the decline or elimination of one species and another species, either native or introduced, fills the void left by the other.

In 1994, the Northwest Power Planning Council adopted the recommendations set forth by the Coeur d'Alene Tribe to improve the Reservation fishery. These recommended actions included: 1) Implement habitat restoration and enhancement measures in Alder, Benewah, Evans, and Lake Creeks; 2) Purchase critical watershed areas for protection of fisheries habitat; 3) Conduct an educational/outreach program for the general public within the Coeur d'Alene Reservation to facilitate a "holistic" watershed protection process; 4) Develop an interim fishery for tribal and non-tribal members of the reservation through construction, operation and maintenance of five trout ponds; 5) Design, construct, operate and maintain a trout production facility; and 6) Implement a five-year monitoring program to evaluate the effectiveness of the hatchery and habitat improvement projects.

Since that time, much of the mitigation activities occurring within the Coeur d'Alene sub-basin have had a connection to the project entitled "Implement of Fisheries Enhancement Opportunities on the Coeur d'Alene Reservation", which is sponsored and implemented by the Coeur d'Alene Tribe Fisheries Program and is the subject of this report. These activities provide partial mitigation for the extirpation of anadromous fish resources from usual and accustomed harvest areas and Reservation lands.

Study Objectives

The study objectives for this annual report are more fully described in the document titled: *Interim Scope of Work and Budget Request, July – August 2002, Implement Fisheries Enhancement Opportunities on the Coeur d'Alene Indian Reservation; Project # 1990-044-00*. This 2002 Annual Report summarizes previously unreported data collected to fulfill the contractual obligations for this project during the 2002 calendar year; specifically tasks related to monitoring and evaluation of biological, chemical and physical attributes of target streams (Objective 1, Tasks 1a and 1b) and to the operations and maintenance of existing enhancement sites (Objective 4, Task 4c). The methods sections herein describe biological monitoring (which focuses on cutthroat and brook trout in the streams), water quality monitoring in streams, and physical habitat monitoring that was instituted on a trial basis. The biological results section describes trout population estimates, age and growth analyses and migration within the streams. Water quality monitoring results are presented and discussed in relation to their effect on fish populations. Initial work with physical habitat assessments followed the guidelines published in a draft Restoration, Monitoring and Evaluation Plan (Vitale et al. 2003a) and the results are presented here; with these surveys focusing on channel profiles, and cross sections, substrate and canopy cover. A summary of operations and maintenance activities at enhancement sites is presented as part of the discussion.

Study Area

The study area addressed by this report consists of the southern portion of Coeur d'Alene Lake and four 3rd – 4th order tributaries which feed the lake (see *Figure 1*). These areas are part of the larger Coeur d'Alene sub-basin, which lies in three northern Idaho counties Shoshone, Kootenai and Benewah. The basin is approximately 9,946 square kilometers and extends from the Coeur d'Alene Lake upstream to the Bitterroot Divide along the Idaho-Montana border. Elevations range from 646 meters at the lake to over 2,130 meters along the divide. This area formed the heart of the Coeur d'Alene Tribe's aboriginal territory, and a portion of the sub-basin lies within the current boundaries of the Coeur d'Alene Indian Reservation.

Coeur d'Alene Lake is the principle waterbody in the sub-basin. The lake is the second largest in Idaho and is located in the northern panhandle section of the state. The lake lies in a naturally dammed river valley with the outflow currently controlled by Post Falls Dam. The lake covers 129 square kilometers at full pool with a mean depth of 22 meters and a maximum depth of 63.7 meters.

The four tributaries currently targeted by the Tribe for restoration are located almost exclusively on the Reservation (*Figure 1*) and have a combined basin area of 34,853 hectares and include 529 kilometers of intermittent and perennial stream channels. The climate and hydrology of the target watersheds are similar in that they are influenced by the maritime air masses from the pacific coast, which are modified by continental air masses from Canada. Summers are mild and relatively dry, while fall, winter, and spring brings abundant moisture in the form of both rain and snow. A seasonal snowpack generally covers the landscape at elevations above 1,372 meters from late November to May. Snowpack between elevations of 915 and 1,372 meters falls within the "rain-on-snow zone" and may accumulate and deplete several times during a given winter due to mild storms (US Forest Service 1998). The precipitation that often accompanies these mild storms is added directly to the runoff, since the soils are either saturated or frozen, causing significant flooding.

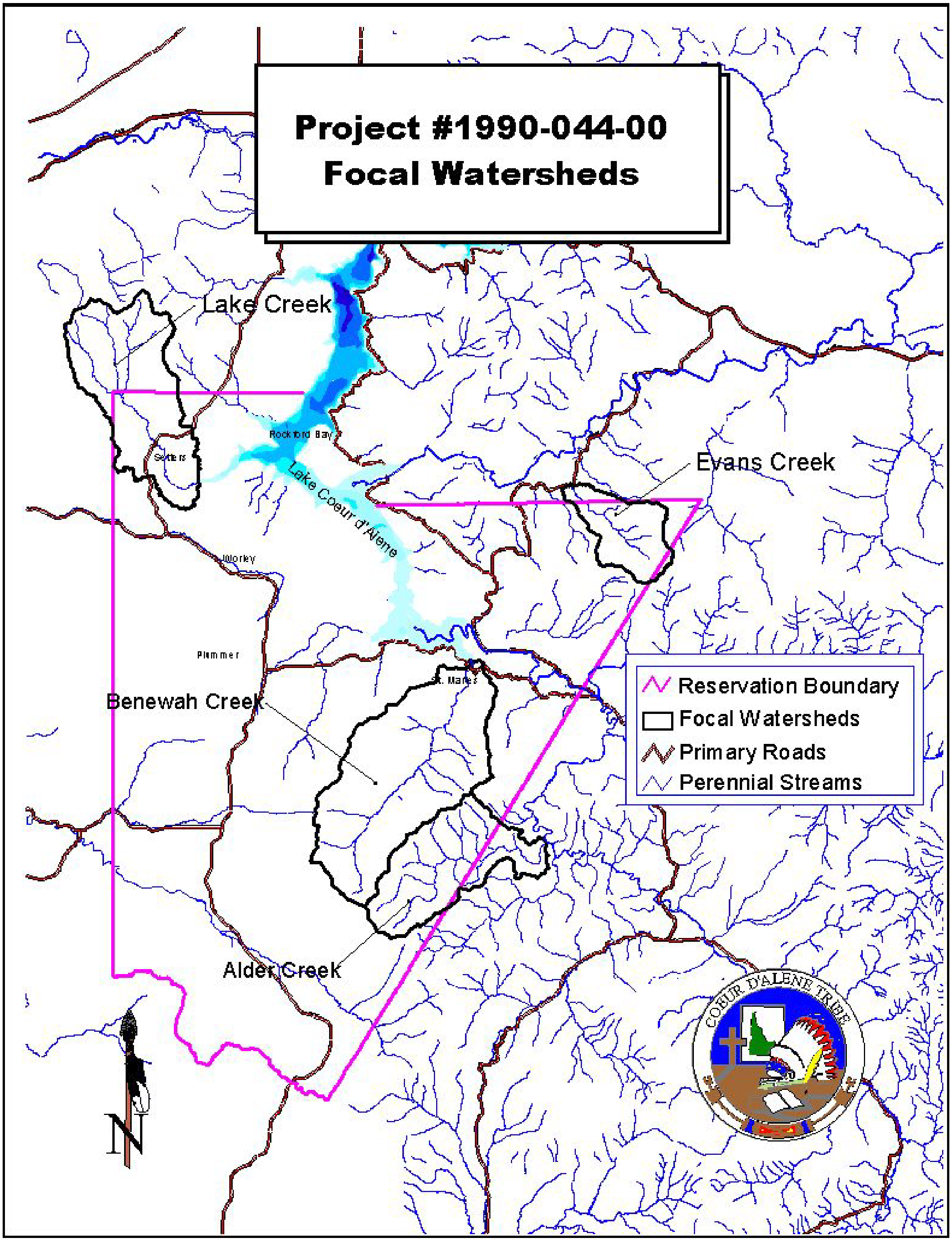

Figure 1. Locations of BPA Project 90-044-00 Focal Watersheds on the Coeur d'Alene Indian Reservation.

METHODS

Biological Monitoring

Trout Population Estimation

The channel types delineated during previous surveys (Lillengreen et al. 1996) served as the basic geomorphic units for selecting sample sites for conducting fish population surveys. In these early channel type surveys, stream reaches were stratified into relatively homogeneous types according to broad geomorphologic characteristics of stream morphology, such as channel slope and shape, channel patterns and channel materials, as defined by Rosgen (1994). Stream reaches were further stratified by basin area to ensure that both mainstem and tributary habitats were represented in the stratification scheme. Sample locations within each strata were randomly selected in proportion to the total reach length. The length of each sample unit was defined as 200 meters.

Sites were electrofished in the summer to quantify the abundance and distribution of fishes during base flow conditions occurring between July and September. Trout populations were estimated using the removal-depletion method (Seber and LeCren 1967, Zippen 1958). Block nets were placed at the upstream and downstream boundaries to prevent immigration and emigration during sampling. Each sample site was electrofished using the standard guidelines and procedures described by Reynolds (1983). Fish were collected by spot shocking using a Smith-Root Type VII pulsed-DC backpack electrofisher. Two electrofishing passes were made for each sample site as the standard procedure. If the capture probability during the initial passes was less than or equal to 50 percent, then a third and/or fourth pass were generally made to increase the precision of the population estimate. Salmonid species, including cutthroat trout, brook trout, and bull trout, were the target species for this study. Captured fish were identified, enumerated, measured (TL to nearest mm), and weighed (g). Cutthroat trout greater than 200 mm in length were tagged with a Floy FD-6B numbered anchor tag. Other species such as longnose dace, redside shiner, longnose sucker, and sculpin (spp.) were considered incidental catch and were only counted.

Population estimates were calculated using the following equation for two pass removals (Armour et al. 1983):

$$N = \frac{U_1}{1-(U_2/U_1)}$$

where:
N = estimated population size;
U_1= number of fish collected in the first pass; and
U_2= number of fish collected in the second pass.
The standard error of the estimate was calculated as:

$$se(N) = \sqrt{\frac{M(1-M/N)}{A-\left[(2p)^2(U_2/U_1)\right]}}$$

where:
se(N) = standard error of the population estimate;
M= $U_1 + U_2$;
A= $(M/N)^2$; and
p= $1-\frac{U_2}{U_1}$.

Population estimates when more than two passes were necessary were calculated using the following equation (Armour et al. 1983):

$$N = \frac{M}{1-(1-p)^t}$$

where: N = estimated population size
M = sum of all removals ($U_1 + U_2 + \ldots U_t$)
t = the number of removal occasions
U_i = the number of fish in the i^{th} removal pass
C = $(1)U_1 + (2)U_2 + (3)U_3 + \ldots(t)U_t$
R = (C-M)/M
p = $(a_0)1 + (a_1)R + (a_2)R^2 + (a_3)R^3 + (a_4)R^4$
a_i = Polynomial coefficient from Table 8 (Armour et al. 1983).

The standard error was calculated as:

$$se(N) = \sqrt{\frac{N(N-M)M}{M^2 - \frac{N(N-M)(tp)^2}{(1-p)}}}$$

where: se(N) = standard error of population estimate. The approximate 95% confidence interval on the unknown population size was calculated as follows (Armour et al. 1983):

$$95\%CI = N \pm 2 * \sqrt{\text{var}(N)}$$

The population estimates were converted into density values (# fish/100 square meters) for each sample site then extrapolated to the reach in which the samples were collected to estimate the total number of fish in the reach. The confidence intervals were converted in the same manner (Johnson and Bhattacharyya 2001). Total reach areas were obtained from the digital data layer maintained by the Tribal GIS Program.

Trout Age and Growth

Raw scales were used for age determination and calculating growth rates. Salmonid scales were taken from the side of the body just behind the dorsal fin and above the lateral line (Jearld 1983). Scale samples were sorted by watershed to allow for independent determination of age and growth rate. In the laboratory, several dried scales were mounted between two glass microscope slides and viewed using a Realist, Inc., Vantage 5 microfiche reader. Age was determined by counting the number of annuli (Lux 1971, Jearld 1983). Simultaneous to age determination, a measurement was made from the center of the focus to the furthest edge of the scale. Along this line, measurements were made to each annulus under a constant magnification. Annual growth was then back calculated using the Lee method as described by Carlander (1981):

$$L_i = a + \left(\frac{L_c - a}{S_c}\right) S_i$$

where:
L_i = length of fish (in mm) at each annulus;
a = intercept of the body scale regression line;
L_c = length of fish (in mm) at time of capture;
S_c = distance (in mm) from the focus to the edge of the scale; and
S_i = scale measurement to each annulus.

The intercept (a) was obtained from the linear regression of body length versus scale length at time of capture. The proportional method of back-calculation was used for species with small sample sizes with R^2 values less than 0.95. The following equation was used:

$$L_i = \left(\frac{S_i}{S_c} \right) L_c$$

This formula does not take into account the size of fish at scale formation as does the Lee method.

A linear regression of body length versus age was calculated independently for fish from each subject watershed and the resulting equation was used to determine the age of fish for which scale samples were not taken.

Trout Migration

Migration traps were installed in Lake, Benewah, Fighting and Cherry creeks in 2002 to assess migratory life history patterns, length and age frequency distribution, relative abundance and condition factors of adfluvial cutthroat trout. In the past, both the feasibility of installing and maintaining traps and the ultimate efficiency of trapping efforts has largely been determined by the runoff patterns of the respective watersheds. The periodic, low duration peaks in the hydrograph related to rain-on-snow events and/or heavy rains generally result in very low trapping efficiency during these events. Traps were installed April 14 and were monitored and maintained until June 7. Traps consisted of a weir, runway and a holding box. The design was a modification of the juvenile downstream trap found in Conlin and Tuty (1979). Two traps were installed at each location to capture both fish moving upstream from the lake and fish moving downstream from the upper watershed. Paired traps were placed approximately 10 meters apart. Traps were checked and cleaned at least once daily during peak spawning periods from April through the mid-May. Fish captured in the traps were identified, counted, measured, and weighed. A scale sample was taken to assess the age, growth, and condition of the fish.

Water Quality Monitoring

Lake Studies

Coeur d'Alene Tribe Fisheries and Water Resources Programs staff monitored stations in the southern section of Coeur d'Alene Lake from Rockford Bay south to the St. Joe River. Selection of sample stations was based on representative geomorphology, visual habitat characteristics, and the potential for changing water quality conditions during the course of the year. Thirteen sample stations were selected (*Figure 2*) to encompass all four water quality management zones identified in the Coeur d'Alene Lake Management Plan. These sites were not randomly selected and do not include a majority of the deep open water zone, which is a major factor in controlling the water quality of the outflow leaving Coeur d'Alene Lake.

There are five distinct habitat areas in the southern third of Coeur d'Alene Lake that can be distinguished based on geomorphologic condition. Monitoring stations (sites) have been established in each of these habitat areas (*Table 1*). The first of these areas is shallow water created entirely by inundation from Post Falls Dam. There are two monitored stations within this shallow water area. This area is dry during the winter drawdown period and wetted at full pool. The second habitat area is comprised of the three shallow, southern chain lakes along the St. Joe River: Benewah Lake, Chatcolet Lake and Hidden Lake. These lakes were separated from the Coeur d'Alene Lake system until the completion of Post Falls Dam. The third area consists of three deep, open water sections within the main body of Coeur d'Alene Lake. These areas are considered pelagic in nature and include University Point, Windy Bay deep and Conkling Park. Note that a previously monitored site, Mid Lake CDA, was dropped and the University Point site added starting in 2002. The fourth habitat area consists of three semi-isolated shallow bay areas located in the main Coeur d'Alene Lake. The fifth area is riverine habitat inundated by waters from Post Falls Dam. Lake data reported herein are aggregated by these habitat types (see Results and Discussion sections below).

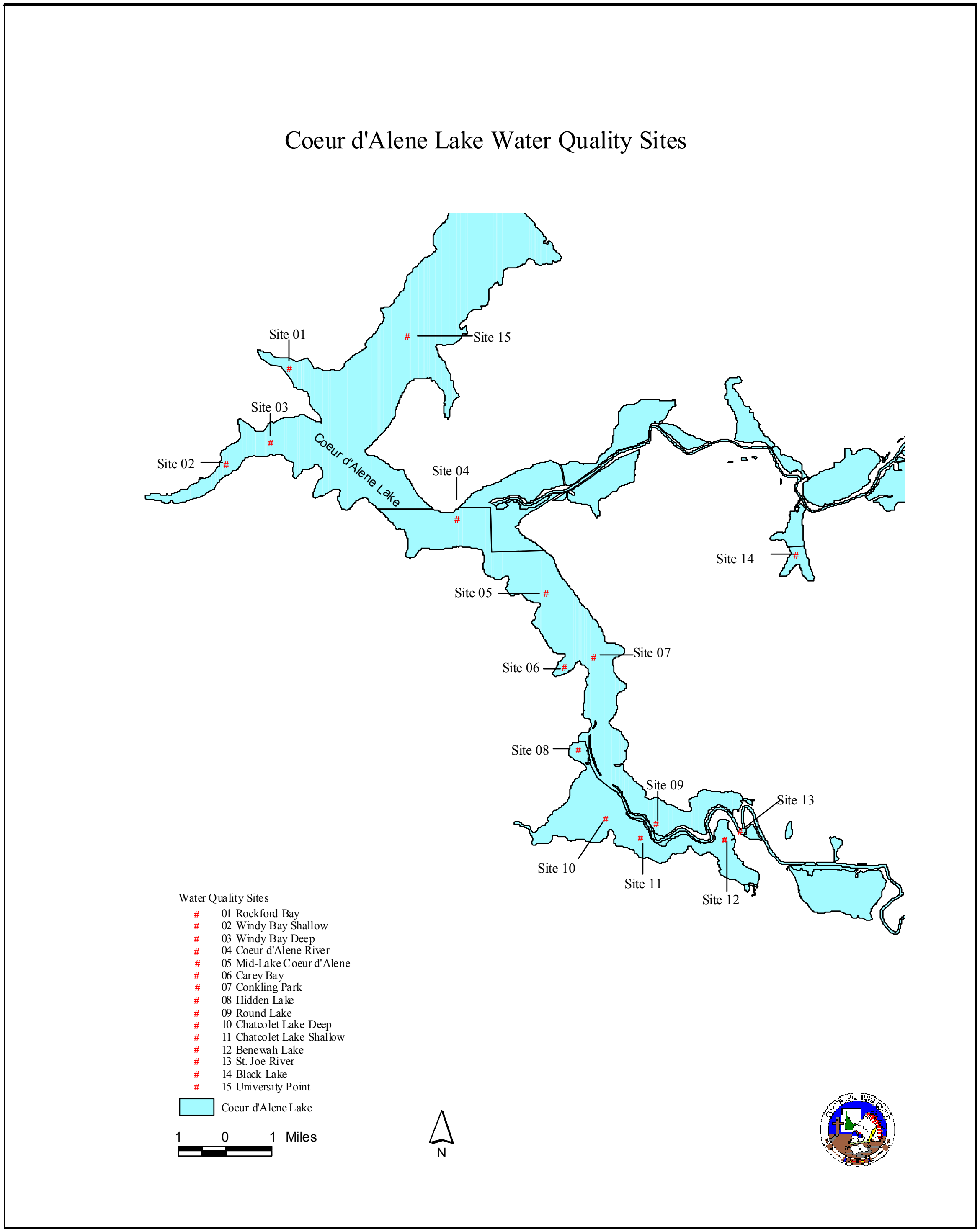

Figure 2. Water quality sample sites on Coeur d'Alene Lake

Monitored Parameters
Temperature, dissolved oxygen, pH, and conductivity were monitored at each station using a Hydrolab H20 multi-probe transmitter. Quality control was maintained through strict adherence to the standard operating procedures outlined in the Hydrolab manual (Hydrolab Corporation 1997). Field measurements were completed by lowering the instrument by cable to the bottom and bringing it back up in one or two meter intervals pausing at each interval to allow the readings to stabilize then recording the values.

A standard 20 cm Secchi disk was used to estimate the transparency of water. Transparency measured in this way is the mean of the depth at which the Secchi disk disappears when viewed from the shaded side of the boat and at which it reappears upon raising after it has been lowered beyond visibility.

Water samples submitted for laboratory analysis were collected using a certified water collection device (Kemmerer-style sampler) and transferred to the appropriate containers for transportation to the contract laboratory. All samples were handled according to Standard Methods for the Examination of Water and Wastewater, 18th Ed. (APHA 1992), procedure 1060: *Collection and preservation of samples*. Strict chain of custody procedures was followed, as outlined in section 1060.B.1: *Chain of custody procedures* (APHA 1992). All containers used were prepared by the contract laboratory.

Total Suspended Solids (TSS) was analyzed using EPA method 160.2: *Gravimetric determination of Total Suspended Solids* (USEPA 1983). TSS is defined as the residue left on a filter paper of 2 μm or smaller pore size after a portion of sample has been filtered and dried.

A qualified contract laboratory completed turbidity analysis in accordance with standard method 2130B: *Nephelmetric determination of turbidity* (APHA, 1992) and/or EPA method 180.1 (USEPA 1993). Turbidity is an expression of the optical property that causes light to be scattered and absorbed rather than transmitted in straight lines (APHA, 1992).

Table 1. Coeur d'Alene Tribe monitored lake water quality sample sites grouped by habitat area.

Habitat Area	Stations
Shallow Water	09 Round Lake
	11 Chatcolet Lake Shallow
Shallow Chain Lakes	12 Benewah Lake
	10 Chatcolet Lake Deep
	08 Hidden Lake
Shallow Bays	06 Carey Bay
	02 Windy Bay Shallow
	01 Rockford Bay
Deep Open Water	07 Conkling Park
	15 University Point
	03 Windy Bay Deep
Rivers	04 Coeur d'Alene River
	13 St. Joe River

All metals samples were handled as described previously for collection of water for laboratory analysis. Metals samples were preserved by acidification to 2% HNO_3 as soon as possible after collection. Metals samples were analyzed using EPA method 200.7/200.8: *Inductively Coupled Plasma Scan* (USEPA 1994) by a qualified contract analytical laboratory. The following trace elements were analyzed: zinc, silica, antimony, barium, beryllium, magnesium, arsenic, sodium, aluminum, calcium, copper, silver, lead, cadmium, cobalt, nickel, manganese, iron, chromium.

Water samples for analysis of nutrient content were collected in the same manner as for turbidity and metals. Nutrient sampling consisted of a euphotic zone composite sample determined by Secchi disk and temperature analysis, and a hypolimnetic composite sample with the upper portion of the stratum determined by the temperature profile. Composite sampling was in accordance with APHA method 1060.A.3.B: *Composite sample collection procedure 1060 collection and preservation of samples* (APHA 1992). The contract laboratory analyzed nutrient samples with an ion chromatograph (IC) using EPA method 300.0 (USEPA 1983). The following nutrient compounds were tested for using this method: ortho-phosphate, nitrate, and nitrite. Other ions looked at were fluoride, chloride, and sulfate.

Chlorophyll *a* samples for primary productivity determinations were collected in amber colored bottles and placed directly on ice. Samples were collected at the same locations as nutrients. A contract laboratory completed sample analysis using procedure 10200 parts 1: P*igment Extraction* and 2: S*pectrophotometric Determination of Chlorophyll* (APHA 1992).

Monitoring Timing and Schedule

The monitoring schedule was designed to capture data related to significant changes in the water quality throughout the year. This included physical/chemical characteristics, nutrient characteristics, and phytoplankton growth. Sampling was initiated just prior to the onset of the growing season in the spring and continued until the lake turned over in the fall, marking the end of the growing season.

The following parameters were monitored at all sites on a monthly basis throughout the growing season: temperature, pH, dissolved oxygen, and conductivity. Surface to bottom depth profiles were taken for each of these parameters. Turbidity was monitored at all sites on a monthly basis. Trace heavy metals were monitored at only three sites on a monthly basis. Composite samples for turbidity and trace heavy metals were taken in the euphotic zone and the hypolimnion. Composite nutrient samples were taken at all sites in the euphotic zone and the hypolimnion on a monthly basis from July to November. Chlorophyll *a* samples were taken at the same time and frequency as the nutrients.

Stream Studies

Water quality monitoring was conducted on 15 stream sites during 2002 (*Table 2*). Each stream was sampled for the same parameters as described above for lake studies, except for chlorophyll *a*. Additional monitoring parameters are described below. In addition, 10 of the stream sites had RL 100 continuous temperature monitoring devices placed during the April through October period.

Table 2. Stream water quality sites and monitoring parameters.

Location	Discharge	Temperature	DO	pH	Conductivity	Turbidity	TSS	Nutrients
Alder Creek	X	X	X	X	X	X	X	X
North Fork Alder Creek	X	X	X	X	X	X	X	X
Upper Benewah Creek	X	X	X	X	X	X	X	X
3 Mile Benewah Creek	X	X	X	X	X	X	X	X
9 Mile Benewah Creek	X	X	X	X	X	X	X	X
West Fork Benewah Creek	X	X	X	X	X			
School House Creek	X	X	X	X	X	X	X	X
Whitetail Creek	X	X	X	X	X	X	X	X
Windfall Creek	X	X	X	X	X	X	X	X
Evans Creek	X	X	X	X	X	X	X	X
Upper Evans Creek	X	X	X	X	X	X	X	X
East Fork Evans	X	X	X	X	X	X	X	X
Bozard Creek	X	X	X	X	X	X	X	X
Lower Lake Creek	X	X	X	X	X	X	X	X
Upper Lake Creek	X	X	X	X	X	X	X	X

Discharge measurements were taken in accordance with standard IFIM methodologies (Bovee 1982). The wetted stream channel was divided into 20 equal cells and water velocity was measured in each cell using a Price model 622 digital flow meter. Discharge for each cell was calculated by multiplying the cell width by depth and velocity. All individual cell discharges were summed to determine total discharge in cubic feet per second.

Physical Habitat Evaluation

The implementation of restoration efforts on the Coeur d'Alene Reservation is one means the Tribe is using to partially mitigate for lost anadromous fisheries through restoration of key habitats for westslope cutthroat trout. At the reach scale, habitat capacity is affected by biotic (e.g., riparian vegetation) and physical (e.g., flooding) processes. Superimposed on the natural biotic and physical processes are anthropogenic stressors (e.g., logging, roads and grazing) that suppress habitat capacity and can result in simplified, degraded stream reaches. The effectiveness of habitat restoration, measured as an increase in native trout abundance, is dependent on reducing limiting factors (e.g., passage barriers, high water temperatures, sediment transport from source areas) in areas that are critical for spawning and rearing lifestages.

In 2002 the Tribe completed a Research Monitoring and Evaluation (RM&E) Plan which described the rational, goals, objectives and procedures to be followed in determining the effectiveness of implemented restoration measures. Concurrent with the development of this Plan, field technician crews were sent out to selected reference sites to begin collecting data on certain stream habitat characteristics. The specific data collected during 2002, which was primarily from the Benewah Creek drainage, focused on longitudinal and cross section profiles, substrate assessment and canopy cover density. While the protocols for these and other monitoring efforts are detailed in the RM&E Plan (Coeur d'Alene Tribe 2002), a summary of those protocols used for the 2002 monitoring is presented below.

Longitudinal "Thalweg" Profile

The slope of the water surface is a major determinant of river channel morphology, and of the related sediment, hydraulic, and biological functions (Leopold 1994). A longitudinal profile surveyed along a selected channel reach is generally used for slope determinations (Rosgen 1996). With a sufficient array of longitudinal profile data, specific characteristics of rifles, runs, glides, and pools can be compared between each feature and between features of other stream types.

This effort involved the measurement of the water surface and channel bottom elevations along a longitudinal transect corresponding to the channel thalweg (modified from Peck et al. 2001). Measurements required the use of a surveyor's level and rod and a measuring tape or "hip chain". Operating and note taking procedures for this equipment are described in the RM&E Plan (Vitale et al. 2003a). The various stream habitat types encountered along the transect were classified using definitions modified from IDEQ (1999) and elevations were recorded at frequent intervals to denote changes in gradient.

Data from this survey allow for the calculation of the proportion and descriptive characteristics (e.g., pool/riffle ratios, max depth ratios, etc.) of all habitat types, channel sinuosity, and channel complexity. This procedure also established the upstream and downstream ends of the monitored reach as well as preliminary locations of six cross sections that will be used for monitoring other stream characteristics.

Collected survey data was input into a "Reference Reach Spreadsheet" (Ohio Department of Natural Resources 1999) that automatically graphs the profiles and also calculates pertinent descriptive criteria such as water surface slope.

Valley Cross Section Profiles

Cross section profiles were measured using a surveyor's level and rod at (or near) the six locations that were staked and flagged during the "thalweg" profile work. The cross section locations were distributed in proportion to the primary habitat types identified during the longitudinal profile *(Table* 3). All cross sections were monumented with permanent pins to allow for consistent measurement during collection of all measurements.

Collected cross section survey data was input into the "Reference Reach Spreadsheet" (Ohio Department of Natural Resources 1999), along with the longitudinal profile data, which automatically graphs the profiles and also calculates pertinent descriptive criteria such as bankfull elevation and flood prone elevation.

Table 3. Stream habitat type descriptions (IDEQ 1999).

Habitat type	Description
Riffle	A portion of the stream with swiftly flowing, shallow water. The water surface in a riffle is turbulent and this is caused by completely or partially submerged obstructions. Cascades are one class of riffle characterized by swift current, exposed rocks and boulders, considerable turbulence and stepped drops over steep slopes. Riffle areas with standing waves are called rapids.
Pool	A portion of the stream with reduced current velocity (average velocity is generally less than 1 foot per second), and often, but not always, with water deeper than surrounding areas. Pools usually have flat water surfaces with no surface agitation and often the bottom is concave such that it would hold water if there was no flow. Pools usually occur at outside bends in the channel and around large obstructions. Water impounded upstream of channel blockages, typically a log jam or beaver dam, is classed as a dammed pool. Pools end where the stream bottom approaches the water surface and this is also known as a "pool tailout".
Run/glide	A portion of the stream with moderate to swift velocity and without surface agitation (runs display "laminar" or uniform flow patterns). Runs and glides typically occur immediately upstream and downstream of riffles. Pool tailouts are typically classed as runs in small high-gradient streams. Glides also occur where the channel widens allowing the stream to shallow and slow. Glides are most commonly found in low gradient streams associated with elongated pools.
Shallows or side channels	A portion of the stream where side channels enter or leave the main channel and shallow, border areas used by young fish.

Channel Substrate

While channel bed and bank materials influence the cross-sectional form, plan-view, and longitudinal profile of rivers, they also determine the extent of sediment transport and provide the means of resistance to hydraulic stress (Ritter 1967). Channel substrate was measured using a modified version of Wolman's (1954) pebble count method as described by Rosgen (1993). The modified method adjusts the material sampling locations so that various bed features are sampled on a proportional basis along a given stream reach as described above for Valley Cross Section Profiles. The pebble count substrate analysis was performed along each of the six cross sections within the monitored reach. At each cross section the actual substrate materials were determined at 20 points spaced uniformly across the bank full width. At each of these points a measuring stick was placed on the substrate and the one particle the tip touched was picked up and measured along the intermediate axis. Substrate size classes were recorded consistent with Rosgen (1996) as shown in *Table* 4.

Collected pebble count data was input into a "Reference Reach Spreadsheet" (Ohio Department of Natural Resources 1999) which automatically graphs the distribution of particle sizes and calculates pertinent descriptive criteria such as percent by substrate class (size) and a particle size index (D value) for each habitat type for which data is indicated.

Table 4. Stream channel substrate particle size classes (from Rosgen 1996).

Class Name	Size Range*	Description
Silt/Clay	<0.062 mm	Silt / Clay
Sand	0.062 - 0.125 mm	Very fine sand
"	0.125 - 0.25 mm	Fine sand
"	0.25 - 0.50 mm	Medium sand
"	0.50 - 1.0 mm	Coarse sand
"	1.0 - 2.0 mm	Very coarse sand
Gravel	2.0 - 4.0 mm	Very fine gravel
"	4.0 - 5.7 mm	Fine grave
"	5.7 - 8.0 mm	Fine gravel
"	8.0 - 11.3 mm	Medium gravel
"	11.3 - 16.0 mm	Medium gravel
"	16.0 - 22.6 mm	Coarse gravel
"	22.6 - 32.0 mm	Coarse gravel
"	32.0 - 45.0 mm	Very coarse gravel
"	45.0 - 64.0 mm	Very coarse gravel
Cobble	64.0 - 90.0 mm	Small cobble
"	90.0 - 128 mm	Small cobble
"	128 - 180 mm	Large cobble
"	180 - 256 mm	Large cobble
Boulder	256 - 362 mm	Small boulder
"	362 - 512 mm	Small boulder
"	512 - 1024 mm	Medium boulder
"	1024 - 2048 mm	Large - very large boulder
Bedrock	>2048 mm	Bedrock

* Measured as median dimension, not largest or smallest)

Canopy Cover

Measurements of canopy cover were made using a spherical densiometer, as described by Platts et al. (1987), to determine relative canopy "closure" or canopy density as a surrogate for the amount of shade over the stream channel provided by riparian vegetation. Platts defined this measure of canopy density simply as the amount of the sky that is blocked by vegetation. Measurements were all made during mid-summer to minimize the natural variance associated with changes in canopy characteristics of mixed coniferous/deciduous plant communities.

Canopy cover over the stream was determined at each of the six cross sections established during the longitudinal thalweg survey. At each of the six cross sections densiometer readings were taken at the following locations: once facing the left bank, once facing upstream at the middle of the channel, once facing downstream at the middle of the channel and once facing the right bank. Percent density was calculated by multiplying the sum of the four readings by 1.5. For results between 30 and 65%, 1.0 %

was subtracted to give the mean density for the transect; if the result was greater than 65, 2% was subtracted to give the adjusted mean. The adjusted density readings were then averaged for the entire reach.

Channel Typing

The classification of stream channel types will follow guidelines presented by Rosgen (1996) and includes both an office map review effort (Level I) and field inspection effort (Level II). The objective of classifying streams on the basis of channel morphology is to use discrete categories of stream types so that consistent, reproducible descriptions can be developed. These descriptions must provide a consistent frame of reference to document changes in the stream channels over time and to allow comparison between different streams. The different Rosgen classifications are described in *Table 5* (note that Entrenchment ratio and Width- to- depth ratio are determined as part of the Level II analysis.

Table 5. General stream type descriptions and delineative criteria for broad-level classification (from Rosgen 1996).

Stream Type	General description	Entrenchment ratio	W/D ratio	Sinuosity	Slope %	Landform/soils/ features
Aa+	Very steep, deeply entrenched, debris transport streams.	< 1.4	< 12	1.0 to 1.1	> 10	Very high relief. Erosional, bedrock or depositional features; debris flow potential. Deeply entrenched streams. Vertical steps with deep scour pools; waterfalls.
A	Steep, entrenched, cascading, step/pool streams. High energy/debris transport associated with depositional soils. Very stable if bedrock or boulder dominated channel.	< 1.4	< 12	1.0 to 1.2	>10	High relief. /erosional or depositional and edrock forms. Entrenched and confined streams with cascading reaches. Frequently spaced, deep pools in associated step/pool bed morphology.
B	Moderately entrenched, moderate gradient, riffle dominated channel, with infrequently spaced pools. Very stable plan and profile. Stable banks.	1.4 to 2.2	>12	>1.2	2 to3.9	Moderate relief, colluvial deposition, and/or structural. Moderate entrenchment and W/D ratio. Narrow, gently sloping valleys. Rapids predominate with scour pools.
C	Low gradient, meandering, point-bar, riffle/pool, alluvial channels with broad, well defined floodplains.	>2.2	>12	>1.2	<2	Broad valleys with terraces, in association with floodplains, alluvial soils. Slightly entrenched with well-defined meandering channels. Riffle/pool bed morphology.
D	Braided channel with longitudinal and transverse bars. Very wide channel with eroding banks.	n/a	>40	n/a	<4	Broad valleys with alluvium, steeper fans. Glacial debris and depositional features. Active lateral adjustment with abundance of sediment supply. Convergence/divergence bed features, aggradational processes, high bedload and bank erosion.
DA	Anastomosing (multiple channels) narrow and deep with extensive, well vegetated floodplains and associated wetlands. Very gentle relief with highly variable sinuosities and W/D ratios. Very stable streambanks.	>2.2	highly variable	highly variable	<0.5	Broad, low-gradient valleys with fine alluvium and/or lacustrine soils. Anastomosed geologic control creating fine deposition with well vegetated bars that are laterally stable with broad wetland floodplains. Very low bedload, high wash load sediment.
E	Low gradient, meandering riffle/pool stream with low W/D ratio and little deposition. Very efficient and stable. High meander width ratio.	>2.2	<12	>1.5	<2	Broad valley/meadows. Alluvial materials with floodplains. Highly sinuous with stable, well vegetated banks. Riffle/pool morphology with very low W/D ratios.
F	Entrenched meandering riffle/pool channel on low gradients with high W/D ratio.	<1.4	>12	>1.2	<2	Entrenched in highly weathered material. Gentle gradients with a high W/D ratio. Meandering laterally unstable with high bank erosion rates. Riffle/pool morphology.
G	Entrenched "gully" step/pool and low W/D ratio on moderate gradients	<1.4	<12	>1.2	2 to 3.9	Gullies, step/pool morphology with moderate slopes and low W/D ratio. Narrow valleys or deeply incised in alluvial or colluvial materials, I.e. fans or deltas. Unstable, with grade control problems and high bank erosion rates.

RESULTS

Biological Monitoring

Trout Population Estimation

As reported in past years (Peters et al. 1999; Lillengreen et al. 1996, Vitale et al. 2003b), cutthroat trout were sporadically distributed in the Alder, Benewah, Evans, and Lake Creek watersheds during base flow conditions in the summer (*Table 6*). The Lake Creek watershed had mean densities more than two times that of any other watershed (14.4/100 m^2). Cutthroat trout abundance in second order tributaries was consistently much higher than in adjacent mainstem reaches for Benewah Creek (mean = 14.7 fish/100 m^2 versus 0.09 fish/100 m^2), Evans Creek (mean = 18.5 fish/100 m^2 versus 5.3 fish/100 m^2), and Lake Creek (mean = 25.3 fish/100 m^2 versus 10.5 fish/100 m^2) despite the effects of low flow conditions. Of all the target watersheds, abundance has been consistently lowest in Alder Creek, with part of the mainstem and North Fork Alder Creek completely devoid of cutthroat trout.

Brook trout have been found only in the Alder Creek and Benewah Creek watersheds--their respective dates of introduction are unknown. In the Alder Creek Watershed, brook trout are found in greater numbers than cutthroat trout in all but two stream reaches. Brook trout had a mean density of 14.9 fish/100 m^2 throughout the watershed in 10 sampled reaches (*Table 6*). Densities of brook trout in the reaches of Benewah Creek where they were found ranged from 0.4-34.5 fish/100 m^2 and the mean density of brook trout for the entire watershed was 1.1 fish/100 m^2.

Total fish population estimates by watershed for a 7-year time series of data ending with 2002 were summarized for this report to examine population trends at the watershed scale (*Figures 3-6)*. Linear regressions of total estimated population by year were calculated to consider the statistical properties of the data set. The population trends are generally not well described by linear regressions due to the high between year variability in the data. The best fit in this regression analysis was for brook trout in Alder Creek (r^2=0.72). The best fit for cutthroat trout was seen in the Lake Creek data (r^2=0.46). Regression trends indicated generally increasing numbers of trout in all watersheds and for all populations except for cutthroat trout in Alder Creek. Brook trout numbers in the Alder Creek watershed increased significantly (P=0.015) during the 7-year time series. And brook trout in Benewah Creek and cutthroat trout in Lake Creek increased significantly at the 90% confidence level. High between-year variability masked significant differences for other populations.

Table 6. Trout abundance and distribution by watershed, summer 2002.

			Cutthroat Trout			
Alder Creek Tributary	**Reach**	**Reach Area (m^2)**	**N (95% CI)**	**Area Sampled (m^2)**	**CTT/100 m^2**	**Total N (95% CI)**
Mainstem	4	4158	0	260	0	0
	5	5064	29 (9)	316	9.2	467 (+138/-50)
	6	1823	23 (6)	223	10.3	188 (+50/-16)
	7	16860	12 (2)	818	1.5	253 (+31/-0)
	8	4916	4 (0)	669	0.6	29 (0)
	9	12635	0	595	0.0	0
NF Alder	1	4475	0	483	0.0	0
	2	1403	0	204	0.0	0
	3	2058	0	167	0.0	0
	4	2503	0	56	0.0	0
Total		55895	68 (16)	3790	1.8	937 (+219/-66)

Table 6 (continued). Trout abundance and distribution by watershed, summer 2002.

			Cutthroat Trout			
Benewah Creek Tributary	**Reach**	**Reach Area (m^2)**	**N (95% CI)**	**Area Sampled (m^2)**	**CTT/100 m^2**	**Total N (95% CI)**
Mainstem	1	7422	0	390	0	0
	2	9419	1(0)	1096	0.09	9 (0)
	3	5588	0	186	0	0
	4	16104	2 (0)	688	0.29	47 (0)
	5	2318	0	520	0	0
	8	5656	0	762	0	0
	9	5648	0	669	0	0
	10	25981	0	743	0	0
	11	1399	2 (0)	372	0.54	8 (0)
Bull	1	3685	35 (14)	130	26.8	986 (+382/-136)
Coon	1	2149	21 (0)	130	16.2	347 (0)
School House	1	2741	25 (21)	186	13.3	363 (+311/-68)
SE Benewah	1	6915	28 (10)	186	15.0	1040 (+365/-110)
WF Benewah	1, 2	3205	8 (0)	111	7.2	230 (0)
Whitetail	1	5204	26 (3)	186	13.9	721 (+76/-21)
Windfall	1	5531	38 (12)	297	12.9	711 (+216/-78)
Total		108965	185 (59)	6652	2.8	4462 (+1350/-413)

			Cutthroat Trout			
Evans Creek Tributary	**Reach**	**Reach Area (m2)**	**N (95% CI)**	**Area Sampled (m2)**	**CTT/100 m2**	**Total N (95% CI)**
Mainstem	1	4977	2 (0)	353	0.6	28 (0)
	2	7227	3 (0)	483	0.6	45 (0)
	3	1970	6 (2)	242	2.6	51 (+12/-0)
	4	10127	65 (33)	650	10.0	1016 (+520/-191)
	5	2692	26 (8)	557	4.6	124 (+36/-13)
	6	1178	26 (11)	353	7.5	88 (+38/-11)
	7	2231	29 (10)	316	9.1	203 (+72/-19)
EF Evans	1	3990	13 (1)	93	14.1	562 (+31/-0)
RF Evans	1	2099	15 (4)	74	20.4	427 (+109/-32)
WF Evans	1, 2	1126	26 (12)	130	20.2	228 (+100/-29)
Total		37617	212 (80)	3252	6.5	2773 (+918/-295)

			Cutthroat Trout			
Lake Creek Tributary	**Reach**	**Reach Area (m^2)**	**N (95% CI)**	**Area Sampled (m^2)**	**CTT/100 m^2**	**Total N (95% CI)**
Mainstem	4	2696	41 (13)	539	7.7	207 (+63/-22)
	5	2555	136 (30)	520	26.2	670 (+145/-105)
	6	11668	72 (15)	836	8.6	1005 (+204/-112)
	7	13284	11 (10)	595	1.8	246 (+219/-45)
	8	9715	33 (19)	204	16.0	1550 (+902/-314)
WF Lake	2, 3	6270	48 (9)	334	14.3	894 (+159/-50)
Bozard	1	11085	149 (21)	372	40.2	4452 (+612/-365)
Total		59910	490 (115)	3400	14.4	9024(+2304/-1013)

Alder Creek Tributary	Reach	Reach Area (m2)	N (95% CI)	Area Sampled (m2)	EBT/100 m2	Total N (95% CI)
			Brook Trout			
Mainstem	4	4158	24 (6)	260	9.3	385 (+89/-33)
	5	5064	5 (2)	167	3.0	151 (+58/-0)
	6	1823	*	141	*	*
	7	16860	74 (20)	818	9.1	1530 (+417/-128)
	8	4916	227 (31)	669	34.0	1670 (+229/-171)
	9	12635	62 (25)	595	10.3	1307 (+531/-159)
N. Fork Alder	1	4475	86 (20)	483	17.8	796 (+185/-64)
	2	1403	39 (9)	204	19.2	269 (+62/-15)
	3	2058	25 (4)	167	15.0	308 (+49/-13)
	4	2503	2 (0)	56	3.6	90 (0)
Total		55895	544 (117)	3642	14.9	6506 (+1619/-583)

*Estimate not included in calculations due to high sample error.

Benewah Creek Tributary	Reach	Reach Area (m^2)	N (95% CI)	Area Sampled (m^2)	EBT/100 m^2	Total N (95% CI)
			Brook Trout			
Mainstem	1	7422	0	390	0	0
	2	9419	4 (0)	1096	0.4	34 (0)
	3	5588	0	186	0	0
	4	16104	0	688	0	0
	5	2318	0	520	0	0
	8	5656	0	762	0	0
	9	5648	0	669	0	0
	10	25981	0	743	0	0
	11	1399	0	372	0	0
Bull	1	3685	11 (3)	130	8.2	302 (+80/-19)
Coon	1,2	2149	0	130	0	0
School House	1	2741	11 (4)	186	6.0	164 (+62/-16)
SE Benewah	1	6915	7 (1)	186	3.9	268 (+47/-0)
WF Benewah	1,2	3205	38 (4)	111	34.5	1105 (+101/-41)
Whitetail	1	5204	0	186	0	0
Windfall	1	5531	0	297	0	0
Total		108965	71 (12)	6652	1.1	1873 (+290/-76)

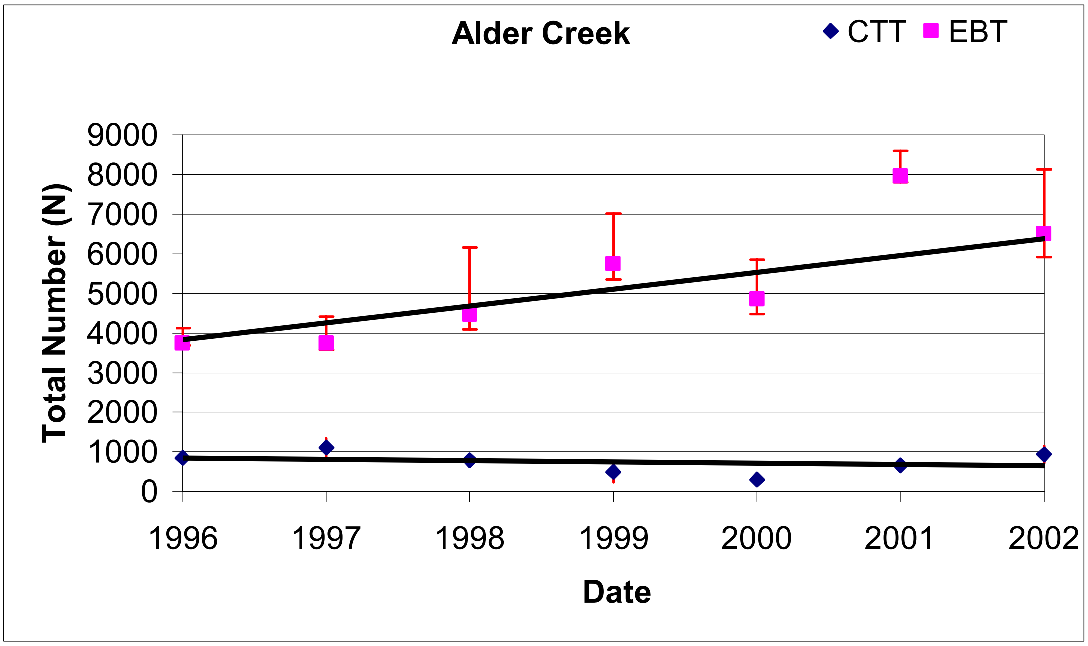

Figure 3. Total estimated population for cutthroat and brook trout in Alder Creek, 1996-2002. Error bars indicate 95% CI.

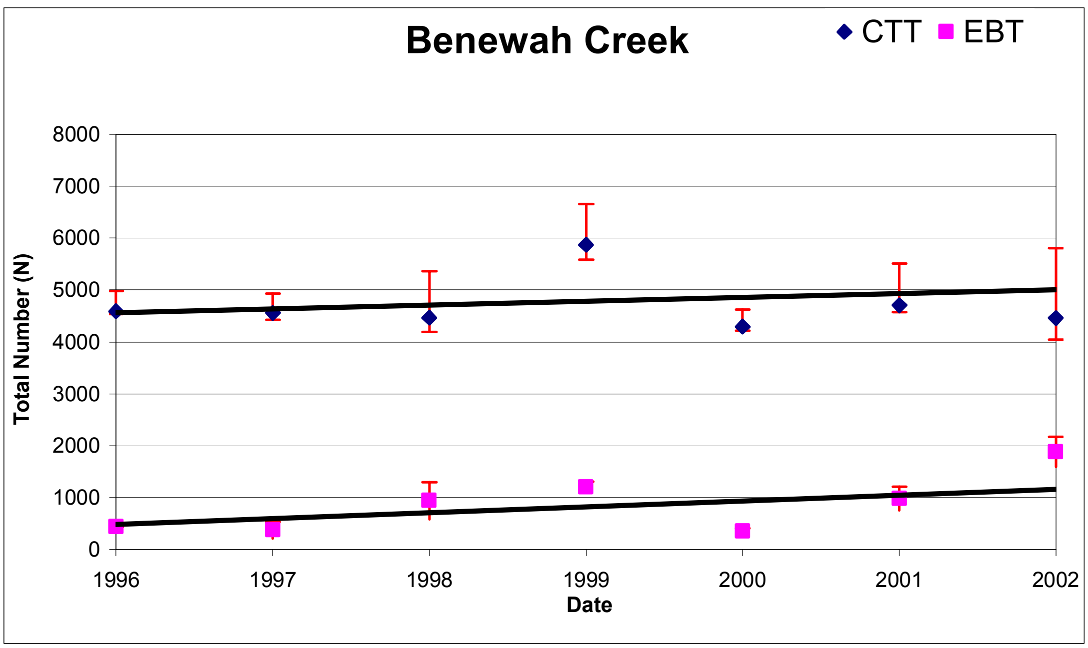

Figure 4. Total estimated population for cutthroat and brook trout in Benewah Creek, 1996-2002. Error bars indicate 95%CI.

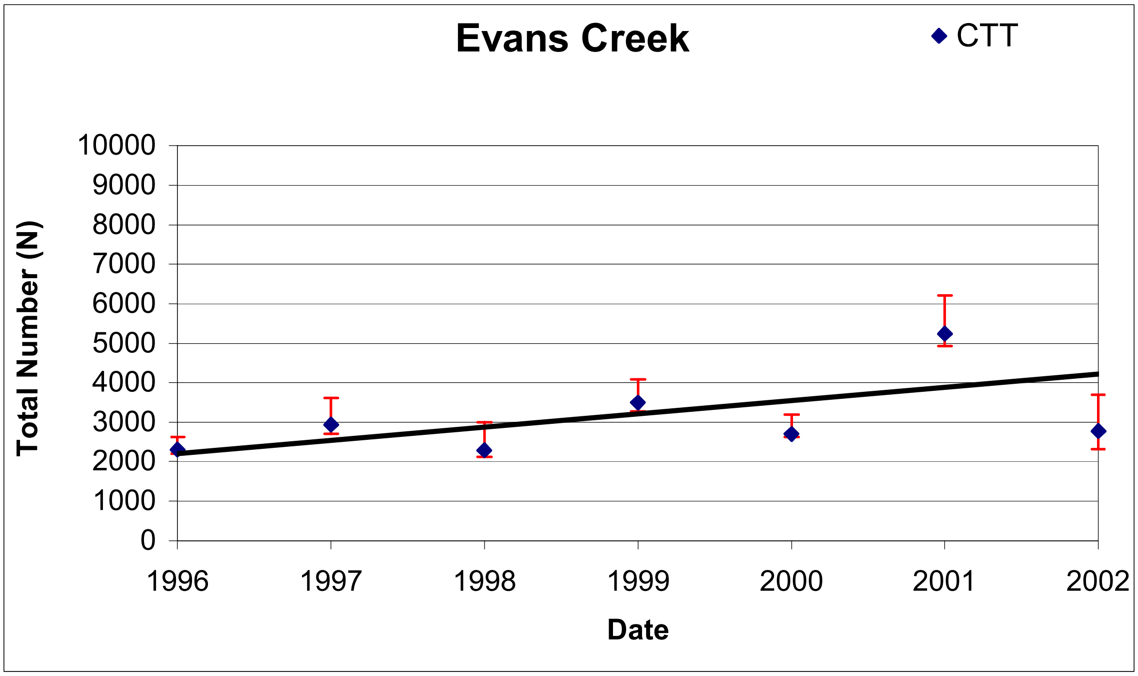

Figure 5. Total estimated population for cutthroat trout in Evans Creek, 1996-2002. Error bars indicate 95%CI.

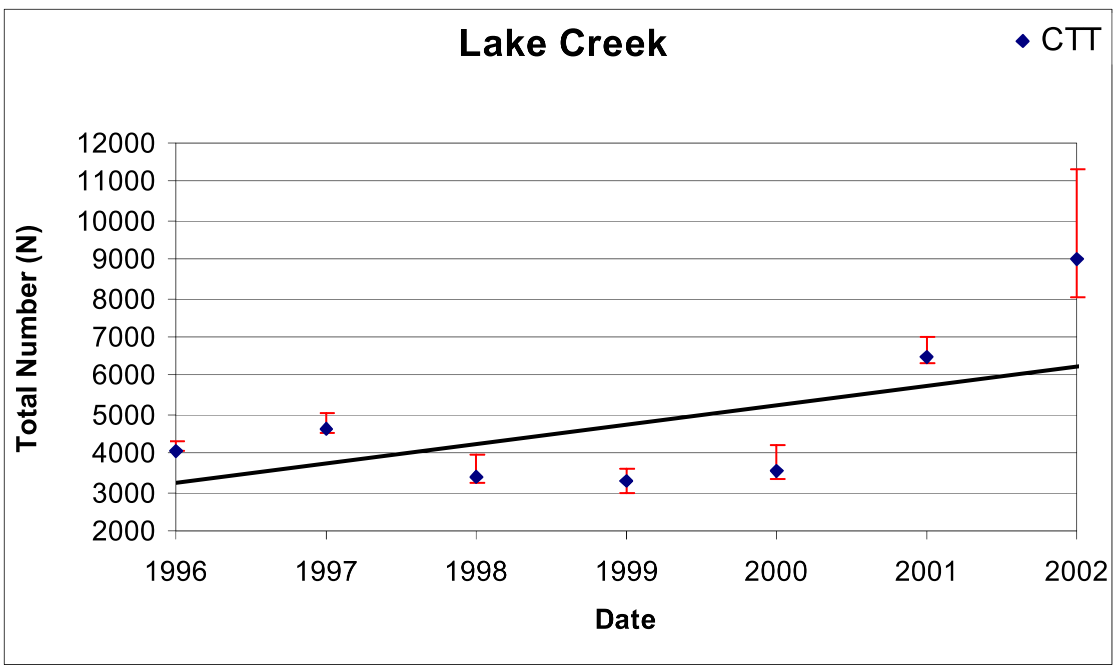

Figure 6. Total estimated population for cutthroat trout in Lake Creek, 1996-2002. Error bars indicate 95%CI.

Trout Age and Growth

A total of 131 cutthroat and brook trout scales were examined for age and growth determination in 2002. As in past years, the adfluvial stocks found in Lake Creek exhibit the maximum growth potential for this species. The largest cutthroat recorded in 2002 was found in Lake Creek and measured 17.7 inches (450 mm TL) and 2.0 pounds (900 grams) and was aged at eight. *Table 7* gives the means and ranges of length and weight for all cutthroat trout aged in 2002. The scale samples include fish captured in migration traps in the spring as well as fish captured during stream electrofishing surveys. A complete analysis of growth for cutthroat trout by watershed is provided in (Appendix B).

Analysis of the age frequency of cutthroat trout caught during stream electrofishing surveys indicated that 96% of the catch consisted of juveniles (age 0-3) when averaged across all watersheds (*Table 7*).

Table 7. Age frequency distribution of cutthroat trout sampled by electrofishing, summer 2002. Ages were extrapolated for all fish that were captured based on the equations developed for back-calculating length at age by watershed (Appendix A).

Watershed	**Age Class**								
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Totals**
Alder	36	7	8	4	3	6			64
Benewah	54	50	38	21	3	2		1	169
Evans	23	59	64	27	7	6			186
Lake	49	278	77	23	5		1		433
Totals	**162**	**394**	**187**	**75**	**18**	**14**	**1**	**1**	**852**

Alder age=(0.0339*TL)-2.6046
Benewah age=(0.0286*TL)-1.8566
Evans age=(0.0212*TL)-1.089
Lake age=(0.0201*TL)-0.536

Trout Migration

A total of 132 cutthroat trout were caught in upstream and downstream traps combined in 2002 at a mean CPUE of 4.3 fish/day. *Figure 3* shows the age classes of migrants in Lake and Benewah Creeks based on regressions of age versus total length (Appendix A). Adult fish (age IV or older) accounted for 84% of the catch in Lake and Benewah Creeks, 86% of these were trapped in the downstream Lake Creek trap.

A total of fifteen cutthroat trout were captured in upstream traps and 117 were captured in downstream traps. *Figure 8* compares the total number of cutthroat trout captured in all traps versus mean daily water temperature. Peak downstream migration corresponded to the lowest recorded water temperatures. The number of cutthroat trout captured in each individual trap is shown in Appendix C.

Although traps were monitored through June 7, 2002, malfunction of a datalogger resulted in a loss of data collected from May 22-June 7. This data, therefore, is not reflected in the results presented here. During this time period a large number of juvenile fish (age 1-3) were captured in traps as they migrated downstream to the lake. This data would have significantly altered the age frequency distribution as well as the overall timing of migrants shown in *Figures 7 and 8*.

Table 8. . Mean lengths, weights and Fulton type condition factors (KTL) with standard deviations and ranges for aged cutthroat trout in 2002.

Age	n	Statistics	Length (mm)	Weight (g)	K_{TL}
		Mean	79	11	0.95
0	5	SD	7	13	0.26
		Range	70-85	3-33	0.74-1.38
		Mean	105	12	0.84
1	9	SD	15	3	0.15
		Range	70-122	8-17	0.58-0.99
		Mean	126	19	0.94
2	9	SD	8	6	0.20
		Range	110-134	13-29	0.73-1.27
		Mean	178	55	0.95
3	17	SD	15	17	0.19
		Range	145-209	30-84	0.78-1.51
		Mean	267	183	0.96
4	1	SD	-	-	-
		Range	-	-	-
		Mean	261	236	1.31
5	3	SD	22	104	0.53
		Range	239-282	134-342	0.98-1.92
		Mean	346	342	0.83
6	17	SD	17	60	0.11
		Range	320-380	260-459	0.60-1.00
		Mean	372	401	0.78
7	31	SD	16	49	0.07
		Range	350-410	321-500	0.65-0.92
		Mean	403	549	0.83
8	16	SD	26	168	0.15
		Range	360-450	315-992	0.61-1.23
		Mean	390	451	0.76
9	1	SD	-	-	-
		Range	-	-	-

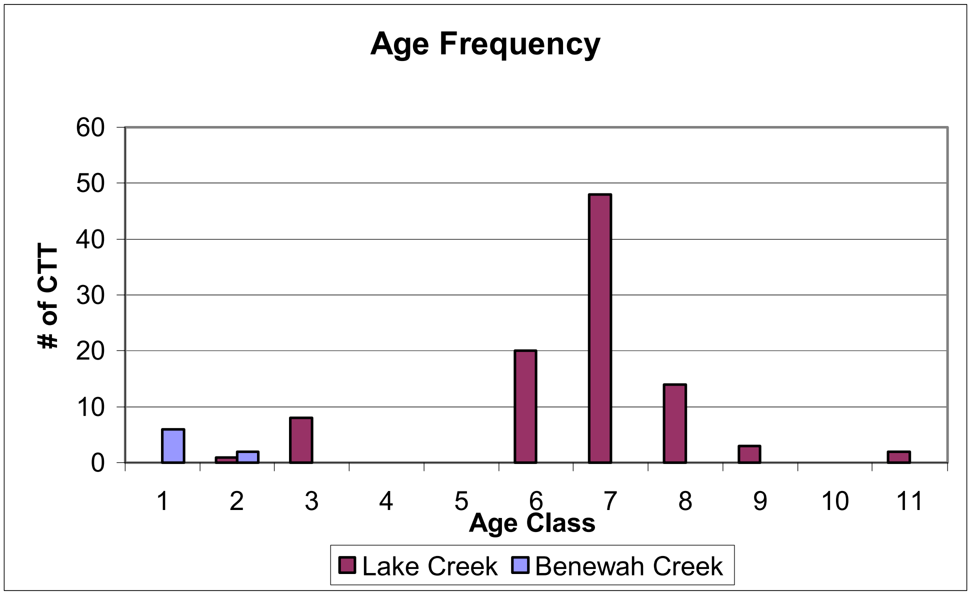

Figure 7. Age frequency of adfluvial cutthroat trout in Lake and Benewah Creeks, 2002.

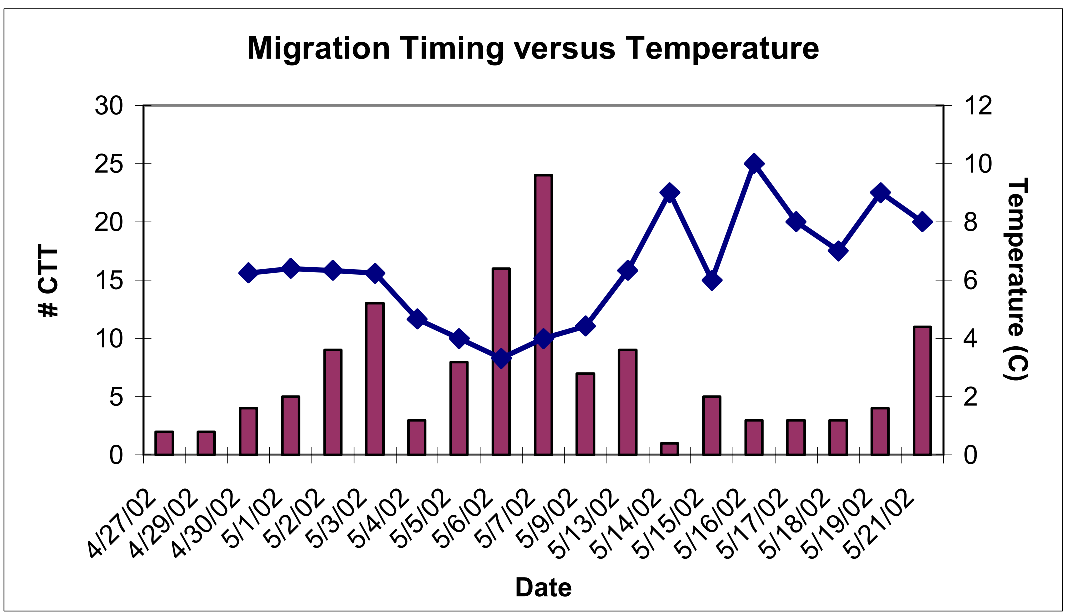

Figure 8. Cutthroat trout migration versus mean daily water temperature. Total cutthroat trout numbers include fish captured in Benewah, Lake, Cherry, and Fighting creeks, 2002.

Water Quality Monitoring

Lake Water Quality

Secchi Disk Transparency

The transparency of the lake water, as measured using a standard Secchi Disk, was seen to increase through the 2002 season as shown in *Table D-1* (Appendix D). The calculated monthly average of all sites with data ranged from a low of 1.42 m in April to a high of 7.09 m in August. Transparency, as shown in this data, increased slowly during April through July, jumped to the August high and then began to decrease in September. There was insufficient data collected this year to determine differences between the habitat areas.

Temperature
Summarized lake temperature data are presented in Table D-2. As with the Secchi results, temperatures generally rose through the April to August period and then began to drop in September. Surface water temperatures exceeded 20° C starting in July and all sites monitored had surface temperatures greater than this level in August.

Dissolved Oxygen
Summarized dissolved oxygen (DO) data for the study period are presented in Appendix D, *Table D-3*. Most DO readings taken during this period varied with temperature in terms of saturation potential. The typical range of DO values seen, in the surface waters (four to six meter depths at least) was 9 - 12 mg/L during April and May and 8 - 10 mg/L during July through September.

Due to the influence of thermal stratification, DO levels in the deeper (hypolimnion) waters can be considerably different than near the water surface. A particular point of reference in this regard is the 6.0 mg/L standard for cutthroat trout. The most noticeable and consistent drop in DO below this level was seen at the three Shallow Chain Lakes sites (Hidden Lake, Chatcolete Lake Deep and Benewah Lake) which were below 2 mg/L in July and below 0.4 mg/L during August and September. The Shallow Bays sites, Deep Open Water sites and Rivers sites for which data was collected generally had hypolimnetic DO levels above (or close to) 6.0 mg/L throughout the year.

pH
Summarized pH data for the study period are presented in Appendix D, *Table D-4*. All pH values measured during 2002 were within the range 5.99 to 8.73. During April and May, the range was somewhat narrower at 6.88 to 7.07 (a single value of 9.89 near the bottom at the Conkling Point site on 5/11 is suspected to be an anomaly) but as the waters warmed the range widened somewhat. At the time of the July sampling the observed range in pH was 6.07 to 8.62, in August the range was 6.42 to 8.73 and in September this was 5.99 to 7.66.

Conductivity
Summarized conductivity data for the study period are presented in Appendix D, *Table D-5*. The overall average of available data for 2002 was 42.7 µs/cm in April, 43.4 µs/cm in May, 28.9 µs/cm in July, 48.5 µs/cm in August and 23.1 µs/cm in September. The interesting aspect of this is that the highs appeared in August and the lows in September.

Stream Water Quality
Stream flow
There were 15 streams or stream segments monitored for water quality parameters and discharge during 2002. Summarized instantaneous flow measurements for all sites with data are given in *Table D-6* in Appendix D. The highest recorded discharge in 2000 was 46.84 cfs at the Lower Lake Creek site on 5/14/02 although alder Creek was close with 46.6 cfs on 3/13/02. The highest flow in the Benewah Creek drainage was 13.85 cfs measured at the 3 Mile site. The highest flow in the Evans Creek drainage was 36.68 cfs at the Evans Creek site. The low flows at almost all sites occurred during October and flows typically increased somewhat in November.

Temperature
Summarized stream temperature data are presented in *Table D-7*. While stream temperatures started and ended the season in the single digits, there was considerable warming observed during the summer months. During May the range of temperatures measured was 0.95 to 11.9 °C with the high temperature being at the Upper Lake Creek site. In June the range was 6.08 top 14.56 °C with the high at the Lower

Lake site. Temperatures peaked in all sites except the Lake Creek sites and 3-mile Benewah in July when the range of values, overall, was 11.03 to 20.89 °C. The overall high temperature for the year was recorded at the Alder Creek site. Recorded water temperature peaked in the Lake Creek sites and 3-mile Benewah during late August with a high of 19.81 °C measured at the Lower Lake site and 19.18 °C at 3-mile Benewah. At this time temperature measured at the other monitored sites ranged from 11.28 to 15.34 °C. Stream water cooled quickly in September, when the overall range was 8.91 to 14.68 °C and by the October monitoring visit the range was only 0.09 to 6.43 °C.

Dissolved Oxygen
Stream site Dissolved Oxygen (DO) data are presented in *Table D-8*. These results generally reflected the temperature data very closely; that is, low Dos were seen at the time of the highest temperatures. Thus, most sites had DO minimum on 7/22/02 (between 8.11 and 10.48 mg/L) while the 3-mile Benewah and the three Lake Creek sites had minima on 8/22/02 (7.70 to 8.91 mg/L). The one notable exception, and the observed low value for the year, was at the Whitetail Creek site which did no show its minimum of 6.60 mg/L until 9/5/02.

pH
Stream site pH data are presented in *Table D*-9. The overall pH results for 2002 were generally circumneutral; the lowest value for the year was 6.18 at the Evans Creek site, and the highest was 9.10 at the Alder Creek site. During May, June and late August through November there was a narrow range of pH values seen, typically 6.3 to 7.5, overall. During July and early August, however, there was a noticeable split with the Alder and Benewah Creek sites showing noticeably higher pH (8.36 to 9.10 on July 11) than the Evans and Lake Creek sites (6.31 to 7.13 on July 11). In fact, the highest pH values for each month was seen at either the Alder Creek main stem site (July, September, October and November) or the 3-mile Benewah site (May, June and August).

Conductivity
Stream site conductivity data are presented in *Table D-10*. The overall range of values seen was 5.9 to 75.20 µs/cm, with the low recorded at the Upper Evans site on 6/7/02 and the high at Alder Creek on 10/22/02. Within this range and time, typical values were more in the range of 15 to 35 µs/cm. From the available data, conductivity appears to be lowest during May and highest during October this year.

Physical Habitat Monitoring

Sites and Parameters Monitored
There were 22 stream sites monitored for physical habitat parameters in 2002, all but one of these were within the Benewah Creek watershed. The other site was on Lake Creek. There were five basic characteristics measured as described in the Methods section, above: the longitudinal (thalweg) profile of the site, six cross section profiles at each site, the substrate materials ("pebble counts"), the canopy cover and valley length. Not all parameters were measured at all sites, however. Table 9 summarizes the sites where various measurements were made.

Longitudinal Thalweg Profiles
The four longitudinal thalweg profiles that were completed in 2002 have been graphed and these graphs appear in Appendix E. These profiles, which were all from the Benewah Creek drainage, show a typically irregular series of riffles, pools and runs with minimal overall channel slope over the monitored reach. The reach length was typically 500 ft except at the B_6.5 restoration site (Evans property), where approximately 2,600 ft were surveyed. Benewah site R8S1 had a slope of 0.82%, the B_6.5 site had a slope of 0.48%, and R11 S2 had a slope of approximately 0.77%. The Windfall R1 S1 site had a slope of only 0.22 %. The water surface slope for these same four sites were 0.7%, 0.4%, 0.8% and 0.1%, respectively. These baseline profiles will be used to compare with future surveys and document any changes in the profile resulting from either aggradation or degradation.

Table 9. Stream sites and physical habitat parameters monitored by the Coeur d'Alene Tribe in 2002.

SITE	Longitudinal Thalweg Profile	Cross Section Profiles	Pebble Counts	Canopy Cover	Valley Length
Benewah R1 S1			X	X	
Benewah R2 S1			X	X	
Benewah R2 S2			X	X	
Benewah R3 S1			X	X	
Benewah R3 S2			X	X	
Benewah R4 S1			X	X	
Benewah R4 S2			X	X	
Coon R5 S1			X	X	
Benewah R8 S1	X	X	X	X	
Benewah R8 S2			X	X	
Benewah R9 S1			X	X	
Benewah R9 S2			X	X	
Benewah Evans (Rest. Site B_6.5)	X	X	X		X
Whitetail R1 S1			X	X	
Benewah R10 S1			X	X	
Benewah R10 S2			X	X	
Benewah R10 S3			X	X	
Benewah R11 S1			X	X	
Benewah R11 S2	X	X	X	X	X
Windfall R1 S1	X	X	X	X	X
Windfall R1 S2			X	X	
Lake Creek R8 S1				X	

Cross Section Profiles
As described in the Methods section, above, six cross sections were located and surveyed within each of the monitored sites. The graphs of each of these appear in Appendix E. Unfortunately bankfull indicators were only identified for two sites, Benewah R11S1 and Windfall R1 S1, so the bankfull elevation (blue line) and flood prone depth (red line) and width could not be determined except at these sites. Bankfull indicator lines on the graphs from the Benewah B_6.5 restoration site were based on constructed channel form and do not necessarily represent the long term expression of bankfull flow features. However, the cross section graphs do provide a good picture of the channel and banks at the cross section locations. Again, these baseline profiles will be compared with future surveys to assess changes over time with regard to streambank erosion and/or lateral stability.

Stream Substrate (Pebble Counts)
Stream substrate assessments (pebble counts) were conducted on selected stream sites in the Benewah Creek drainage during 2002. Pebble count data were input into a "Reference Reach Spreadsheet" which calculated various descriptive indices. In particular, substrate size distribution and particle size index were determined. The particle counts and size distribution graphs for all habitat types combined with summary indices are included in Appendix E.

Of the 21 stream sites assessed, 14 of these were dominated by "cobble" sized material, (typically 64 to 256 mm diameter) as shown in *Table 10***.** Of the remaining sites, five were gravel dominated and two were boulder dominated. The gravel-dominated sites were Benewah R11S1 and R11S2, Whitetail R1S2, and the two Windfall sites. The boulder-dominated sites included the Coon Creek site and Benewah R4S2.

Table 10. Substrate type distribution from pebble count surveys for 2002 monitored stream sites on the Coeur d'Alene Reservation.

	Percent by substrate type					
Site	**silt/clay**	**sand**	**gravel**	**cobble**	**boulder**	**bedrock**
Benewah Evans	0%	0%	47%	53%	0%	0%
Benewah R 1 S 1	23%	2%	26%	50%	0%	0%
Benewah R 2 S 1	17%	1%	23%	48%	11%	0%
Benewah R 2 S 2	0%	0%	17%	33%	20%	29%
Benewah R 3 S 1	0%	0%	13%	47%	28%	13%
Benewah R 3 S 2	0%	0%	19%	63%	18%	0%
Benewah R 4 S 1	0%	0%	15%	52%	33%	0%
Benewah R 4 S 2	0%	1%	19%	27%	29%	23%
Benewah R 8 S 1	0%	0%	15%	48%	28%	9%
Benewah R 8 S 2	0%	0%	23%	69%	8%	0%
Benewah R 9 S 1	4%	0%	28%	44%	6%	18%
Benewah R 9 S 2	0%	0%	45%	48%	7%	0%
Benewah R 10 S 1	0%	0%	31%	52%	5%	13%
Benewah R 10 S 2	21%	0%	38%	41%	0%	0%
Benewah R 10 S 3	0%	0%	47%	53%	0%	0%
Benewah R 11 S 1	3%	0%	87%	9%	0%	0%
Benewah R 11 S 2	12%	18%	56%	13%	0%	0%
Coon R 5 S 1	0%	0%	0%	36%	52%	12%
Whitetail R 1 S 2	37%	0%	38%	25%	0%	0%
Windfall R 1 S 1	29%	14%	57%	0%	0%	0%
Windfall R 1 S 2	31%	0%	56%	13%	0%	0%

Another way of comparing the pebble counts for these sites is through the particle size index (D values). This index gives the maximum size of particle that makes up various percentages (ie. 16, 35, 50, 84 and 95%) of the total count. The summary of this analysis is presented in *Table 11*. From this it can be seen that, in general for the Benewah Creek main stem sites, 95% of the counted stream bed particles were between 100 and 500 mm in diameter (actually, 56% of the Benewah sites were within this range). A notable exception was seen in the R4S2 results where the D95 size was 3,511.6 mm. This result is due to that fact that a large number of counts in the riffle sample were in the bedrock category, which likely skewed the results to the larger size category. This was also true in the Coon creek R5S1 sample,which had the second highest D95 value. The smallest D95 value in this 2002 sample set was seen from the Windfall R1S1 site, which had a D95 of only 34.0 mm. This follows from the fact that no counts were made for materials larger than the gravel sized material at this site.

Canopy Cover

Calculated canopy cover densities for stream stations monitored in 2002 appear in *Table 12*. All sites surveyed (except one on Lake Creek) were in the Benewah Creek drainage, including sites on the Benewah mainstem, Coon Creek, Whitetail Creek and Windfall Creek. The one site on Whitetail Creek was the only area surveyed that had 100% canopy cover and the one site on Lake Creek was the only site with 0% cover. Within the Benewah mainstem, the two sites in Reach 4 appeared to have the highest canopy density with 47.8% and 55.4%, and the two sites in Reach 8 had the lowest with 7.7% and 10.1%. Other Benewah Creek sites had, typically, between 20% and 30% canopy cover.

Table 11. Substrate particle size index summary for 2002 monitored stream sites on the Coeur d'Alene reservation.

	Size percent less than (mm)				
Site	**D16**	**D35**	**D50**	**D84**	**D95**
Benewah Evans	37.8	53.6	68.1	126.0	180.8
Benewah R 1 S 1	#N/A	39.4	63.3	130.7	204.4
Benewah R 2 S 1	#N/A	52.8	89.0	224.6	334.4
Benewah R 2 S 2	30.5	100.5	147.2	337.8	693.5
Benewah R 3 S 1	67.1	122.5	163.9	340.0	558.3
Benewah R 3 S 2	59.4	83.8	116.1	269.7	511.9
Benewah R 4 S 1	66.8	134.9	193.1	432.8	803.4
Benewah R 4 S 2	37.4	99.5	153.2	2502.7	3511.6
Benewah R 8 S 1	62.6	112.3	161.2	382.1	837.4
Benewah R 8 S 2	42.0	81.3	105.3	170.0	332.0
Benewah R 9 S 1	42.7	60.1	79.6	159.5	311.9
Benewah R 9 S 2	29.7	48.3	72.2	208.0	304.2
Benewah R 10 S 1	37.1	63.6	85.8	172.8	269.6
Benewah R 10 S 2	#N/A	33.6	51.0	105.6	180.0
Benewah R 10 S 3	20.8	43.6	68.3	155.3	220.1
Benewah R 11 S 1	17.0	26.0	33.2	55.8	78.6
Benewah R 11 S 2	0.1	8.1	15.6	55.6	99.7
Coon R 5 S 1	163.0	232.6	345.2	1176.2	1722.1
Whitetail R 1 S 2	#N/A	#N/A	32.9	79.5	122.5
Windfall R 1 S 1	#N/A	0.1	6.3	16.0	34.0
Windfall R 1 S 2	#N/A	8.9	14.7	57.3	103.4

Channel Typing

Once the cross section profiles were surveyed, the bankfull indicators noted, a valley length measured and this data input into a reference reach spreadsheet, several key stream morphology indicators were calculated. These indicators will be compared over time to determine if changes are occurring in the shape or profile of the stream in the studied reaches. These indicators include the Entrenchment Ratio, Width to Depth Ratio, Sinuosity and Slope, as discussed in the Methods section, above. In addition, these four indicators are all considerations in determining the stream channel type, following the methods described by Rosgen (1996) as shown in *Table 5*, above. The calculated stream indicators, and the resultant channel type for the three stream reaches that had complete monitoring data sets from 2002 are shown in *Table 13*. From this it is apparent that these reaches have similar channel morphology (‘C’ type) with the primary difference being substrate size.

Table 12. Calculated canopy cover densities for stream stations monitored by the Coeur d'Alene Tribe during 2002.

Stream	Reach	Site	Cover Density (%)
Benewah	1	1	26.5
Benewah	2	1	21.1
Benewah	2	2	43.8
Benewah	3	1	24.4
Benewah	3	2	7.0
Benewah	4	1	55.4
Benewah	4	2	47.8
Benewah	8	1	10.1
Benewah	8	2	7.7
Benewah	9	1	30.2
Benewah	9	2	22.4
Benewah	10	1	19.3
Benewah	10	2	33.7
Benewah	10	3	16.7
Benewah	11	1	14.2
Benewah	11	2	23.3
Coon	5	1	31.0
Whitetail	1	2	100.0
Windfall	1	1	66.2
Windfall	1	2	82.1
Lake	8	1	0.0

Table 13. Stream morphology indicators and channel types for selected study reaches monitored by the Coeur d'Alene Tribe in 2002

SITE	Entrenchment Ratio	Width-Depth Ratio	Sinuosity	Slope	Channel Type
Benewah Creek Evans	2.8	19.0	1.3	0.48	C 3
Benewah Creek R11 S2	2.8	16.8	1.4	0.77	C 4
Windfall Creek R1 S1	2.6	13.8	2.2	0.22	C 4

DISCUSSION

Trends For Stream Fisheries

The regressions performed on the total estimated number of trout by watershed indicate stable or increasing population trends for cutthroat except in the Alder Creek watershed where sympatric populations of cutthroat and brook trout are present (*Table 14*). Cutthroat trout also appear to be declining slightly in Alder Creek, although the trend is not statistically significant. Nevertheless, this is an important observation in light of the trend for brook trout numbers. The increase in brook trout numbers in the Alder Creek watershed was significant (P=0.015) and total numbers appear to have increased by more than 2-fold during the 7 year sample period. In Benewah Creek, the increase in brook trout was significant at the 90% confidence level (P=0.085), the estimated numbers of brook trout have remained at their highest levels during the last several years, and have generally exhibited lower variability than for cutthroat in the watershed. Both the regression coefficients and the p-values calculated for brook trout in these watersheds indicated stronger statistical relationships than reported by Vitale et al. (2003b) where the authors examined population trends in the same watersheds using a 6-year data series. Furthermore, total trout biomass in these watersheds exhibit a generally increasing trend over time with brook trout consistently accounting for a greater proportion of both total fish numbers and biomass. The presence of brook trout in these watersheds may be limiting the ability of native cutthroat to respond to ongoing restoration efforts.

Comments received from the ISRP during the 2001 Provincial Project Review recommended further scrutiny of brook trout/cutthroat relationships in the target watersheds leading to management recommendations (ISRP 2001c). These reviewers and other authors have indicated that cutthroat trout restoration efforts elsewhere in the West generally have not been effective without eliminating or suppressing brook trout (Griffith 1988; Moyle and Vondracek 1985; Varley and Gresswell 1988). The current analysis is consistent with this body of research. Future management of brook trout should place a high priority on implementing control measures in Benewah Creek, where cutthroat trout are still the dominant salmonid and are known to exhibit both resident and adfluvial life histories, and where brook trout exist in relatively low numbers. A well-researched control effort should place an emphasis on a treatment/control approach that examines gains in overall productivity for cutthroat trout following removal or reduction of brook trout. This would require precise measurement of length, weight and age structure for all trout removed from the system while at the same time continuing to conduct annual population estimates at all existing index sites.

Table 14. Total estimated numbers of cutthroat and brook trout (±95%CI) in target watersheds on the Coeur d'Alene Reservation, 1996-2002. Regression statistics were computed using simple linear regression.

Watershed	1996	1997	1998	1999	2000	2001	2002	Regression	r^2	P-value
Alder										
CTT	845(7)	1108(240)	794(36)	494(270)	302(0)	663(150)	937(219)	y=-39.5x + 79695	0.09	0.49
EBT	3746(384)	3738(676)	4470(1687)	5754(1264)	4864(991)	7966(627)	6506(1619)	y=611.78x – 1E+06	0.72	0.015
Benewah										
CTT	4587(391)	4556(374)	4465(903)	5870(784)	4294(334)	4706(807)	4462(1350)	y=-8.78x + 22268	0.001	0.93
EBT	431(0)	369(164)	935(363)	1201(105)	352(53)	978(224)	1873(290)	y=177.17x – 353302	0.47	0.08
Evans										
CTT	2302(323)	2933(687)	2290(711)	3498(586)	2704(484)	5236(980)	2773(918)	y=229.75x – 456165	0.23	0.27
Lake										
CTT	4086(255)	4635(423)	3378(584)	3272(351)	3567(625)	6467(525)	9024(2304)	y=666.67x - 1E+06	0.46	0.09

The trends for cutthroat trout in Lake and Evans creeks indicate generally increasing numbers over the past 7 years. The trend for cutthroat in Lake Creek was significant at a confidence level of 90% (p=0.092). The total estimated numbers of cutthroat have been at their highest levels during the last two years and cutthroat showed increased abundance and a more even distribution through some mainstem reaches than in the past. These positive trends cannot be attributed directly to restoration or enhancement actions at this time as the response to improved habitat or water quality is thought to take place over longer time frames (perhaps several generations). This could be a response to fishing regulations, which closed fishing in the target tributaries in 1993. Fishing remained closed in Benewah and Lake Creeks throughout this reporting period. The importance of this data series cannot be overstated as it will continue to serve as a basis for making pre- and post- restoration comparisons of population structure.

Use and Interpretation of Physical Habitat Information

This report documents the results of initial fieldwork that was implemented to standardize the measurement of physical habitat for use in evaluating restoration and enhancement projects on the Coeur d'Alene Reservation. The protocols for evaluating physical habitat data are documented in the Fisheries Program Research, Monitoring and Evaluation Plan (RM&E Plan) (Vitale et al. 2003a). This planning document was drafted partly in response to ISRP comments that arose during the 2001 Provincial Project Review which called for development of monitoring plans that collectively examine the ecological conditions and fish stock status at the subbasin level in a coordinate way to reveal whether the limiting factor diagnoses were correct and whether the problems are being addressed by the cumulative effects of enhancement projects (ISRP 2001a, 2001b). This Plan was also meant to evaluate the success of BPA Project 1990-044-00 on its own merits - independent of other monitoring efforts - by, in part, looking at physical habitat measures at both the reach and watershed scales and tracking changes in these measures over time.

The monitoring program we propose to implement is consistent with the following approaches:

1. Paired treatment/control in which a stream reach is measured for comparison that is not influenced by management activities, but that is of the same stream type and state or condition as the reach being monitored for management impacts.
2. Comparison of measurements using before versus after management. This approach establishes a baseline or calibration of individual reach conditions prior to implementation.

Both of these approaches require that sample sites be stratified so that comparisons are made among reaches with the same lithology, sediment regime, weather patterns, and stream type. This type of stratification was completed for streams in the target watersheds during the development of the RM&E Plan. Guidelines were consistent with those provided by Paulsen et al. (2002) and Hillman and Giorgi (2002) so as to be useful in furthering regional efforts to develop a multi-component monitoring program to assess the effects of actions called for in the NMFS 2000 Federal Columbia River Power System Biological Opinion.

These monitoring approaches are supported by one of the fundamental principles of river systems which states that the physical appearance and operational character of the modern-day river is a product of the adjustment of the river's boundaries to the magnitude of stream flow and erosional debris produced from an attendant watershed (Lane 1955). A corollary to this principle is that both river form and fluvial processes evolve simultaneously and operate through mutual adjustments toward self-stabilization (Rosgen 1996). It follows that instream habitats, whether they are utilized for spawning, summer rearing or over-winter rearing, attain their greatest production potential in stream reaches characterized by low streambank erosion potential; natural succession of riparian plant communities; stable sediment rating curves; accumulations of woody debris; and stable ratios related to the channel dimension, pattern, and profile (e.g., bankfull width/depth, entrenchment, floodprone width, meander width, slope, etc.). Repeated measurement over time will allow for validation of these various measures of stream stability.

One assumption in monitoring changes to physical habitat to demonstrate project effectiveness is that the processes of adjustment and self-stabilization in degraded stream systems occurs at differing rates for treated versus untreated sites. The hypothesis we will test by monitoring physical habitat parameters over time is that restoration/enhancement treatments lead to stable channel forms with commensurate increases in fisheries habitat potential in shorter time frames when compared with untreated reaches.

The RM&E Plan that serves as the guidance document for this monitoring effort was in an early draft form during the summer and fall of 2002. The 2002 field season, therefore served as a testing ground for solving the logistical problems associated with collection, analysis and interpretation of physical habitat data. The three sites where the complete set of channel dimension, pattern and profile data were collected illustrate the value and potential applications of this data set.

The before versus after management approach to monitoring was tested at the treatment site B_6.5 in the Benewah Creek watershed. Project B_6.5 was implemented in 2000 and 2001 to correct several problems associated with historic manipulation of the stream channel. The creek had been straightened and the natural floodplains cleared and drained to develop cropland and pastures adjacent to the creek. Straightening increased the channel gradient, which in turn, increased the channels ability to convey bed material and subsequently caused the channel to degrade. This deeper, incised channel was vertically separated from its floodplain and unable to sub-irrigate the riparian vegetation it once depended upon for stability. The inherent instability of this channel was apparent during direct visual observations and in the pretreatment survey data.

Comparison with the post implementation data collected in 2002 clearly indicated a conversion from an F4 to C4 stream type with significant qualitative changes in the mean values for several important channel variables (*Table 15*). Overall channel gradient was reduced through construction of a longer, more sinuous channel; the meander width ratio was increased by more than two-fold, and floodprone width was increased by more than 89%. The degree of channel entrenchment was greatly reduced, as was the bankfull width/depth ratio. Average bankfull pool depth had increased by 92% within 2 years following construction.

The changes in entrenchment, floodprone width and meander width are particularly significant because they result in lower near bank sheer stress and should lead to a gradual elevating of the local water table. An increase in the duration of soil saturation within the larger floodprone area should ultimately translate into improvements in long-term channel stability as hydrophytic vegetation begins to colonize these soils as well as the more stable point bars that begin to form. Reduction of the bankfull width/depth ratio and the observed increase in average pool depth make more low velocity habitats available to trout for summer and over-winter rearing, both of which have been identified as limiting factors in the watershed. Channel width is further expected to decrease over time provided that natural succession of vegetation communities is allowed to continue uninterrupted. Significant changes like these can be cited as positive improvements, but channel stability and fisheries response will need to be monitored into the future to further validate these results and to provide some measure of statistical confidence for each of the channel variables.

Table 15. Summary of pre- and post enhancement measures of channel condition at site B_6.5 in the Benewah Creek watershed.

Channel Variable	Pre-enhancement	Post-enhancement
Channel type	F4	C4
Sinuosity	1.06	1.3
Channel gradient (%)	0.63	0.48
Entrenchment	1.92	2.8
Meander width ratio	<2.0	5.2
Floodprone width (ft.)	80.2	152.0
Bankfull width/depth	23.2	19.0

The remaining two sites where complete data sets were compiled are also located in the Benewah Creek watershed (Benewah R11_S2 and Windfall R1_S1). No active management has occurred at either of these sites, so for the time being they serve as reference or control reaches for treatments implemented at geomorphically similar sites. Both of these sites are consistent with C4 channel types. These low gradient, meandering, gravel-dominated reaches are generally suited to a wide variety of fish habitat improvement structures and are comparable to many of the areas being targeted for rearing and spawning habitat enhancement.

A significant feature of monitoring at all of these sites is that permanent reference points and monumented cross-sections have been established so that stream stability can be validated. Repeated measures over time will indicate whether the site is: a) aggrading (building up of the bed elevation by deposition), b) degrading (lowering of the base level due to scour), c) shifting of particle sizes of stream bed materials, d) changing the rate of lateral extension through accelerated bank erosion, and e) changing morphological types through evolutionary sequences. A quantitative assessment of this stability information is essential to understanding the processes of channel adjustment and response to watershed change and/or direct disturbance. Other habitat measures such as pool quality, canopy closure, and large woody debris volumes will be added to the monitoring routine in the future. These additional measures should strengthen the correlation of habitat condition to measured trends in fish populations at treatment and control reaches.

During the next several years, collection of monitoring data should proceed at these established sites as well as at each of the paired treatment/control groupings identified in the RM&E Plan. Monitoring at this level of intensity represents a commitment of approximately 32-40 man-hours/site but provides the means to track project effectiveness at multiple scales and to make correlations between physical and biological data sets.

Restoration/Enhancement Activities

For the most part, restoration and enhancement activities in 2002 were severely curtailed at the request of BPA's Contracting Officer to allow for reassignment of project staff to address other project objectives. However, a limited amount of work was conducted at two project sites because activities were either already in progress prior to the reassignment of staff or the work was warranted to prevent imminent and significant degradation of habitat quality and/or loss of previous BPA-funded investments. Both of the sites where work took place were located in the Benewah Creek watershed and project activities are summarized below in *Table 16* and in the Project Summary forms that follow. Locations of the respective activities in relation to other project sites in the Benewah Creek watershed are shown in *Figure 9*.

Table 16. Summary of restoration/enhancement activities for two projects in the Benewah Creek watershed, 2002

Projects			Activity By Year						
Project ID	**Location**	**Treatments**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
B_6.5	RM 6.5-6.9	Channel construction (695m); Riparian planting; Riparian fencing	Population monitoring upstream and downstream	Population monitoring upstream and downstream	Population monitoring upstream and downstream	Population monitoring upstream and downstream	Contract for design work; pre-treatment survey; Landowner agreement 7/00; permitting completed, phase I construction completed; planted 1,675 trees and shrubs	Phase II construction completed; hydroseeded; Planted 1,500 grass/sedge plugs and 1,950 trees and shrubs; completed fence construction; M&E	O&M to repair flood damage to newly constructed meanders and riffles
B_8.9	T45N, R4W, S24 NW ¼	Riparian planting, 12 hectares	Population monitoring upstream and downstream	Population monitoring upstream and downstream	Population monitoring upstream and downstream	Population monitoring upstream and downstream	Hydrologic analysis completed 6/00	Population monitoring upstream and downstream	Channel assessment and development of restoration prescriptions; planted 8,957 trees; physical habitat monitoring;

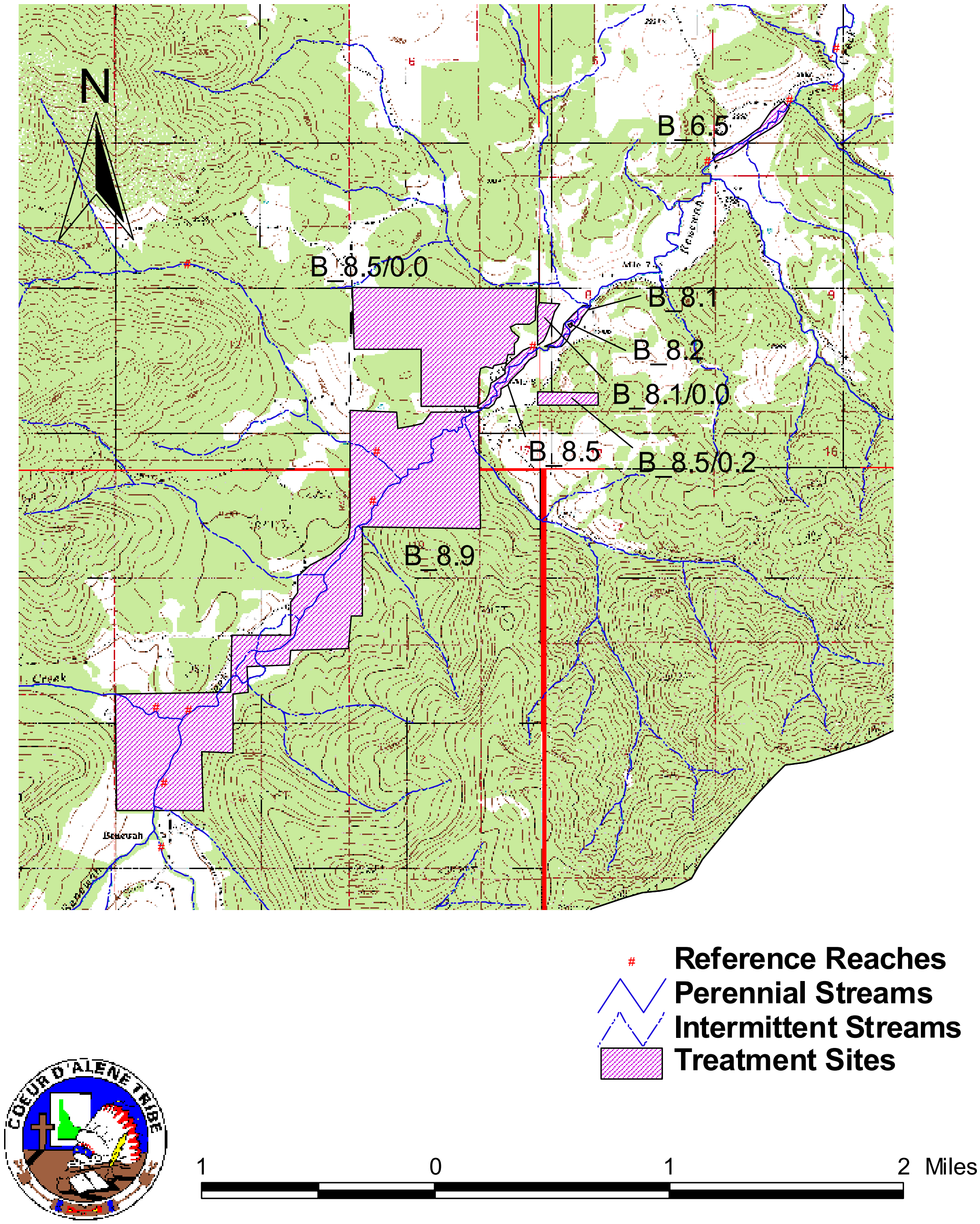

Figure 9. Location of restoration/enhancement activities in the Benewah Creek watershed

BPA PROJECT SUMMARY

PROJECT ID: B_6.5

PROJECT CATEGORY/TREATMENT: Instream/Channel Construction; Riparian/Planting; Riparian/Grazing Management

PROJECT LOCATION:

Watershed: Benewah	Legal: T45N, R3W, S4, SW ¼
Sub Basin (River Mile): RM 6.5-6.9	

SITE CHARACTERISTICS:

Slope/Valley gradient: 1%	Valley Type: B2	Elevations: 2640
Proximity to water: Instream	Channel type: F3 (pre-treatment); C3 (post-treatment)	
Other: Project treats 2,280 linear feet of stream channel and associated floodplain		

PROBLEM DESCRIPTION: A splash dam and flume were constructed on this site between the years 1915 and 1920 to convey logs through the Benewah valley downstream to Benewah Lake and the St. Joe River. Following the dismantling of the splash dam, sometime in the 1930's, the creek was straightened and the natural floodplains cleared and drained to develop cropland and pastures adjacent to the creek. Straightening increased the channel gradient, which in turn, increased the channel's ability to convey bed material and subsequently caused the channel to degrade. This deeper, incised channel was vertically separated from its floodplain and unable to sub-irrigate the riparian vegetation it once depended upon for stability. Recent grazing pressure intensified the problem by reducing plant density and diversity. Streambanks were extremely unstable and instream habitats have little value as summer rearing for cutthroat trout.

Results of the pretreatment channel survey help illustrate these problems: sinuosity=1.06; flood prone width at twice maximum bankfull depth (d_{maxbf})=80.2ft.; Entrenchment ratio=1.92; mean bankfull depth(dbf)=1.8ft.; $width_{bf}/depth_{bf}$ ratio=23.2.

DESCRIPTION OF TREATMENT: Previous work on this site involved implementation of a stream channel design which converted the existing degraded channel from an F4 to C4 stream type by increasing the meander width ratio and sinuosity, lowering the bankfull width/depth ratio, and reducing the channel entrenchment ratio. A new meandering channel, which added nearly 500 ft. of channel length, was constructed and much of the existing unstable channel and floodplain was filled and regraded. The new channel was built just large enough to convey the bankfull discharge within its banks. The controlling riffle elevations were set at a consistent gradient and the bank heights at all the riffles and bends were built so that the banks would overtop simultaneously during flood events. During construction, ten riffles, 4 j-hook structures, and more than 40 pieces of large wood were placed to enhance streambank stability and instream habitat diversity. Additional implementation work conducted from 2000-2001 included riparian planting and fence construction.

During the first two years following construction at the project site moderate bank erosion was observed at two meanders and material was scoured from several of the constructed riffles, which lowered the controlling elevations for the channel at several key points. Several causes for the failures were identified, including 1) assuming during the planning and design phase that sod would be available on site to serve as a short-term bank protection measure when competent sod never existed, and 2) underestimating the need for large wood throughout the site for increased hydraulic friction, bed load sorting and habitat enhancement.

Maintenance work was initiated in 2002 to address the sources of these problems. Work consisted of stabilizing the two meander bends in question and reestablishing grade control at key riffle locations. A total of 160 yds^3 of rock and 6Mbf of large wood was hauled to the site and used to construct 4 J-hook type flow deflectors and 4 cross-vane grade control structures after Rosgen (2000). Remaining rock was used to lengthen and increase the coefficient of friction at four of the constructed riffles, and large wood was partially buried in stream banks and placed adjacent to the bankfull channel to provide habitat enhancement and increase the protection of floodprone areas.

PROJECT TIMELINE: Project implementation required a site inspection by a certified archaeologist and subsequent clearance by the Tribal Cultural Officer and the SHPO (6/00), as well as a wetland delineation (8/00) and USACOE 404 permit (9/00). Phase I channel reconstruction was completed 10/00 and the remaining Phase II channel work was finished by 7/01. Plantings were completed in fall 2000 and also in 2001. Riparian fencing was completed 9/01. The maintenance work conducted in 2002 was completed under USACOE permit NWW No. 001201070 prior to its expiration.

PROJECT GOALS & OBJECTIVES: Restore the channel and floodplain to a naturally appearing and functioning geometry using native materials. Create a stable creek and riparian environment that will naturally develop into optimal fish habitat. Restore a proper bedload balance within the project reach and minimize the flood potential for adjacent cropland.

Project effectiveness should be evaluated by follow-up measurements of channel bed-form, substrate and fisheries response consistent with recommendations in the RM&E Plan.

RELATIONSHIP TO SCOPE OF WORK: The operations and maintenance work completed at this site fulfills the Program commitments for Objective 4, task 4c under the Phase I FY 2002 Scope of Work and Budget Request (Inter-Governmental Contract #10885).

BPA PROJECT SUMMARY

PROJECT ID: B_8.9

PROJECT CATEGORY/TREATMENT: Riparian/Planting

PROJECT LOCATION:

Watershed: Benewah	Legal: T45N, R4W, S24, NW ¼
Sub Basin (River Mile): RM 8.9-11.9	

SITE CHARACTERISTICS:

Slope/Valley gradient: < 1%	Valley Type: B2	Elevations: 2650-2760
Proximity to water: floodplain	Channel type: C4	

Other: Project treats 2,057 linear feet of stream channel and associated floodplain.

PROBLEM DESCRIPTION: The Benewah valley has a history of anthropogenic disturbance by logging and agricultural activities that date to the early twentieth century. Logging removed many of the coniferous trees in the valley bottom between 1915-1930. Splash dams and flumes were developed in the creek to facilitate the movement of harvested logs to down valley mill sites. The combination of direct land clearing adjacent to the creek and the construction and operation of splash dams had a direct affect on channel form and function with negative implications for the productivity of habitats for juvenile rearing. In the most recent past, dating from approximately the 1940's through 2000, the property was managed for grazing and/or hay production, which has precluded the regeneration and establishment of a diverse native riparian plant community along much of the 3.2 miles of streams associated with this property.

Current riparian function is degraded as evidenced by low stream canopy closure, little overhanging vegetation, and low volumes of LWD. The wood that is present in the channel is mostly comprised of small pieces that generally do not function to shape channel morphology or maintain habitat diversity. Also, the existing riparian community offers little potential for providing recruitable large wood in the future. Currently, discharges greater than the 5-year return interval flood begin to exit the existing channel in a non-uniform manner. As a result several avulsion channels have developed that have the potential to cut-off remaining channel length and lead to abandonment of relatively high quality habitat.

This stream reach is located in a portion of the watershed that historically provided important summer rearing habitat for westslope cutthroat. Mainstem reaches of the property were likely utilized as over-winter habitat as well.

DESCRIPTION OF TREATMENT: Tree planting will be undertaken to re-establish forest communities adjacent to the stream channel and provide long-term roughness across the valley bottom. Restoring a forested valley bottom will improve structural habitat conditions in the coming decades and is fundamental in the long-term restoration of this site. An estimated 387 acres will be planted over the next several years as monies for implementation are secured.

A total of 8,957 deciduous and coniferous plants were installed in 2002, treating an area of approximately 30 acres and a little more than 2,000 linear feet of stream channel. Plantings consisted of engelmann spruce, western white pine, ponderosa pine, western larch, lodgepole pine, red-osier dogwood, alder, water birch, black cottonwood and willow. Plant materials consisted of small tublings, containerized plants and live cuttings.

PROJECT TIMELINE: Spring planting work was completed May 15, 2002 and fall planting was completed October 23, 2002. Monitoring of the planting work was performed by the project supervisor periodically during the performance of the work. A conifer survival inspection was conducted on December 6, 2002, at which time the overall survival was determined to be approximately 55%. Along the south edge of the conifer planting area and through the riparian corridor of Windfall Creek, where nearby trees provided shade, the survival was greater than 75%. While in the open meadow area survival was seen to be less than 25%, apparently due to exposure to sun and drying during the summer months. Survival inspections will be repeated in 2003.

Preliminary restoration prescriptions were developed for this project site following completion of a detailed stream channel assessment in October 2002. The prescriptions were outlined in a report entitled, "Benewah Creek Assessment and Restoration Prescriptions (December 2002)" and will be implemented concurrently with the planting efforts described in this summary over the next several years.

Several monitoring activities have been ongoing on this site and were continued in 2002 to support the evaluation of future restoration/enhancement activities. Fish abundance and distribution has been monitored at 4 sites within this stream reach since 1996 and populations were estimated again in 2002. Also, detailed physical habitat surveys were completed at three locations on the property in 2002.

PROJECT GOALS & OBJECTIVES: Goals for this project include 1) increase stream shading; 2) provide a long-term source of large woody debris for natural recruitment; 3) promote bank stabilization; 4) increase riparian species diversity and cover; and 5) enhance stream buffer capacity. Provide for significant increases in canopy density and overhanging vegetation over the next 20 years. Target canopy closure is 92%.

RELATIONSHIP TO SCOPE OF WORK: This project fulfills a portion of the Program commitments for implementation Objective 1, task 1a under the FY 2001 Scope of Work and Budget Request (Inter-Governmental Contract #4593), which was extended through June 2002.

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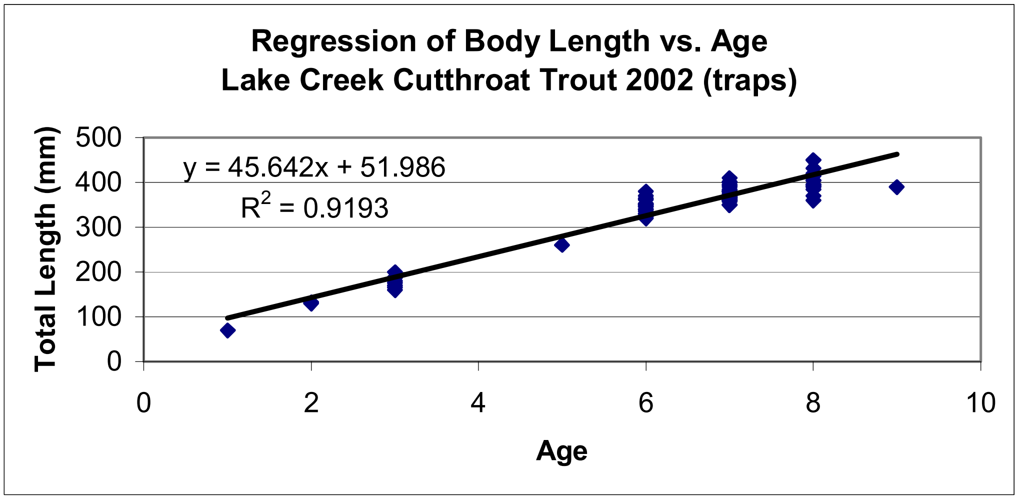
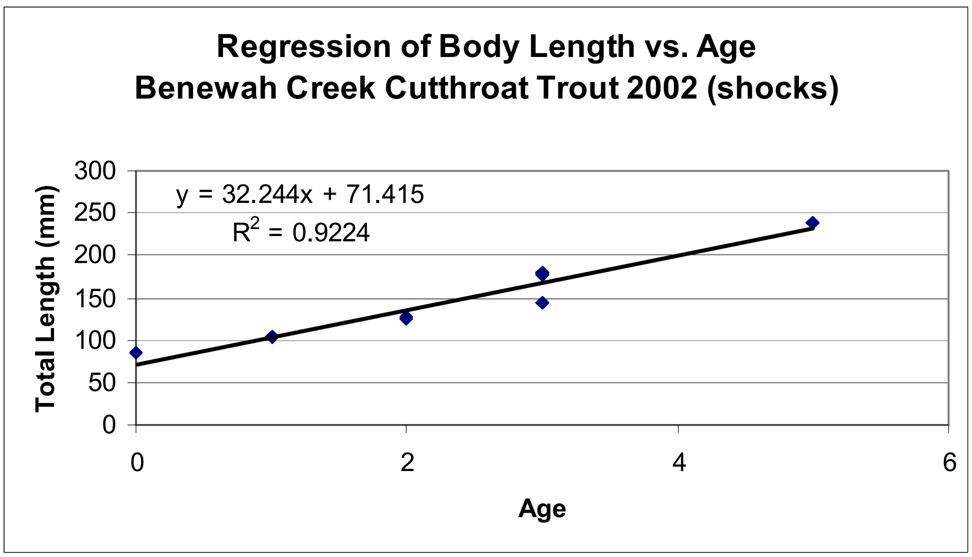
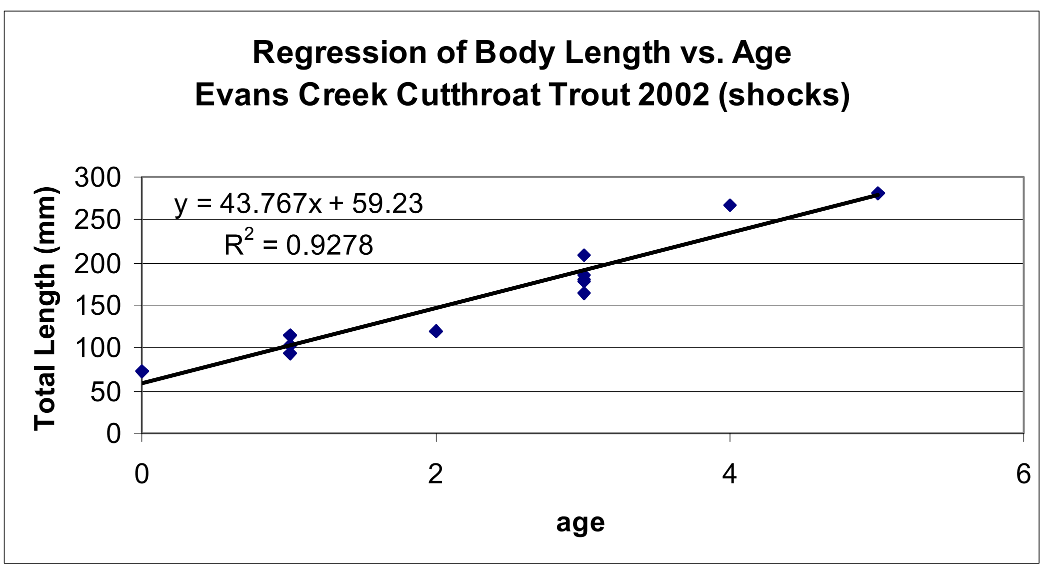
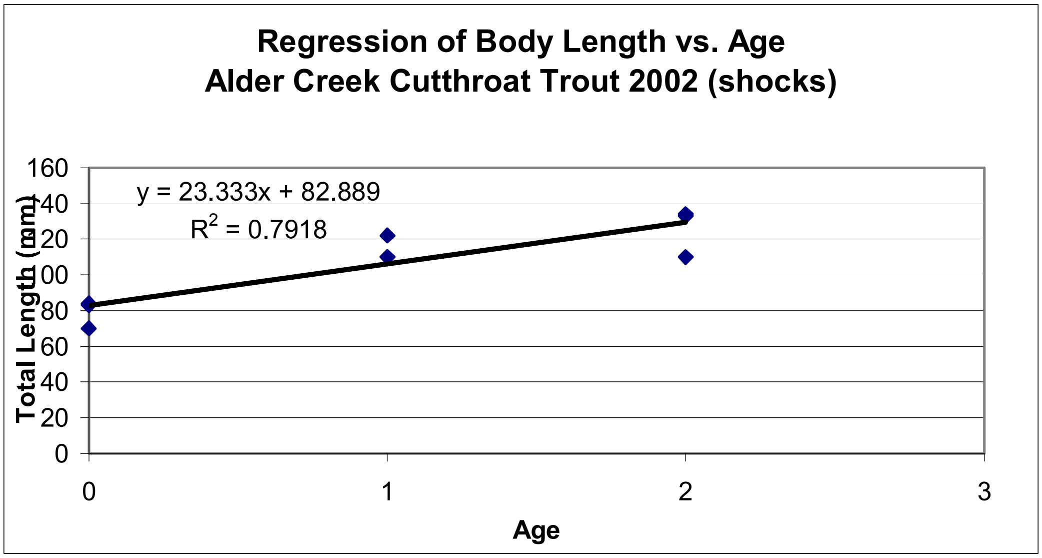
APPENDIX A

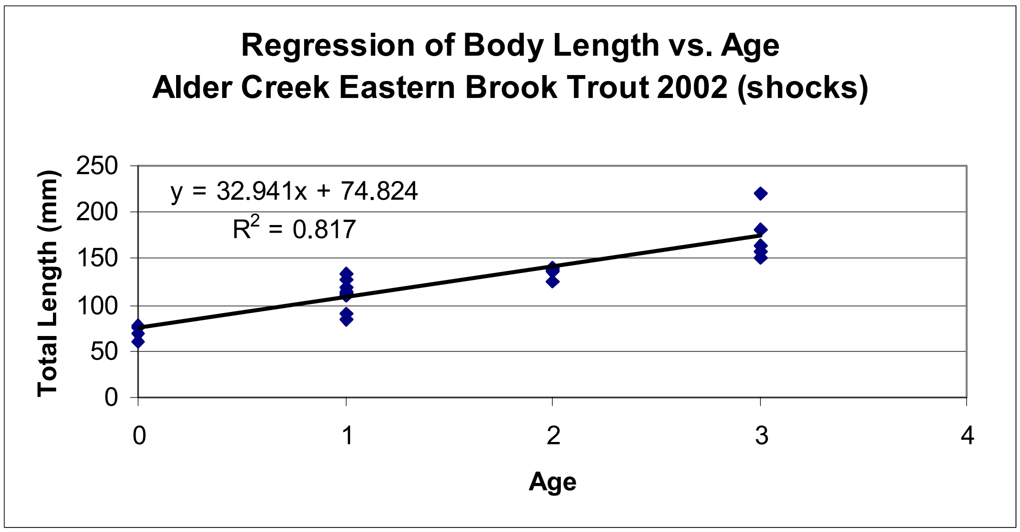
Regressions of total body length versus age for cutthroat trout and brook trout by watershed, 2002. Regression equations are given to back calculate age from the known total length (mm).

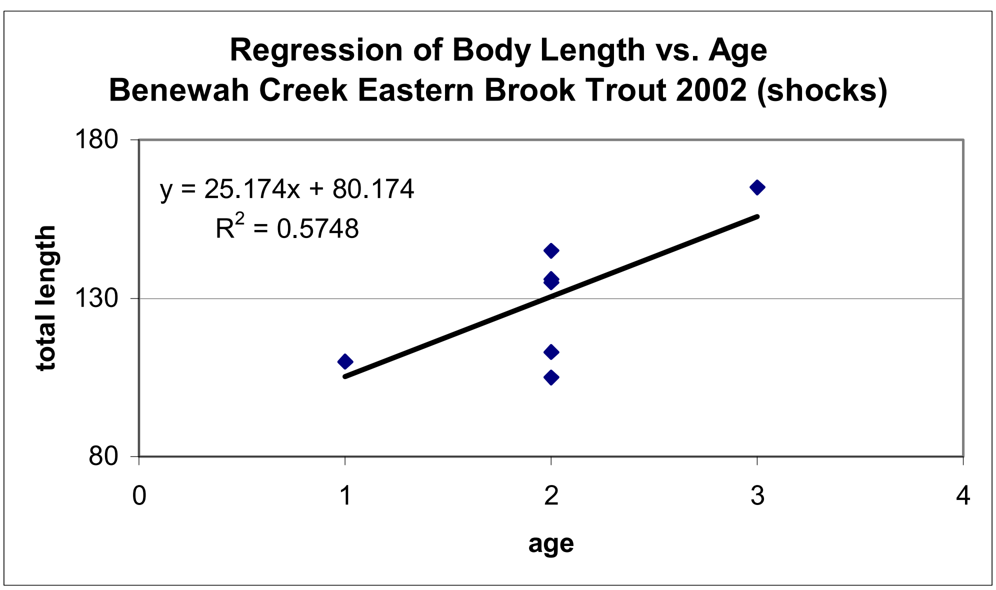

Regression of Body Length vs. Age
Lake Creek Cutthroat Trout 2002 (traps)
y = 45.642x + 51.986
R2 = 0.9193
Total Length (mm)
500
400
300
200
100
0
0
2
4
6
8
10
Age


Regression of Body Length vs. Age
Benewah Creek Cutthroat Trout 2002 (shocks)
y = 32.244x + 71.415
R2 = 0.9224
Total Length (mm)
300
250
200
150
100
50
0
0
2
4
6
Age


Regression of Body Length vs. Age
Evans Creek Cutthroat Trout 2002 (shocks)
y = 43.767x + 59.23
R2 = 0.9278
Total Length (mm)
300
250
200
150
100
50
0
0
2
4
6
age


Regression of Body Length vs. Age
Alder Creek Cutthroat Trout 2002 (shocks)
y = 23.333x + 82.889
R2 = 0.7918
Total Length (mm)
Age
160
140
120
100
80
60
40
20
0
0
1
2
3


Regression of Body Length vs. Age
Alder Creek Eastern Brook Trout 2002 (shocks)
y = 32.941x + 74.824
R2 = 0.817
Total Length (mm)
Age
250
200
150
100
50
0
0
1
2
3
4


Regression of Body Length vs. Age
Benewah Creek Eastern Brook Trout 2002 (shocks)
y = 25.174x + 80.174
R2 = 0.5748
total length
age
180
130
80
0
1
2
3
4

APPENDIX B

Age and growth analysis for cutthroat trout and brook trout in select watersheds of the Coeur d'Alene Reservation, 2002.

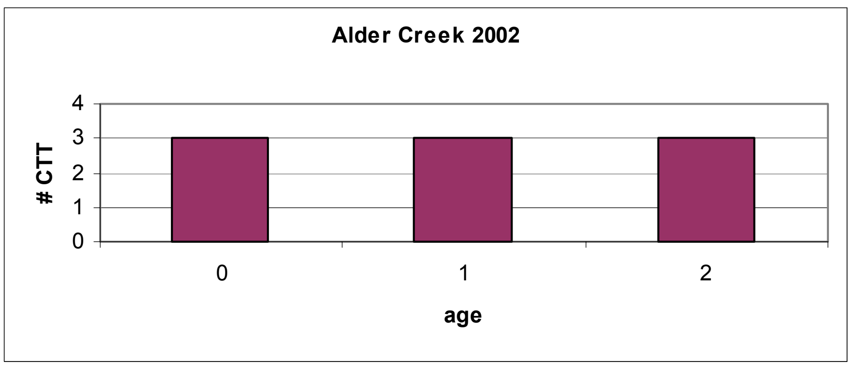
Table B-1. Mean back-calculated lengths at annulus formation by age class and cohort for cutthroat trout, 2002. Standard deviations are in parenthesis.

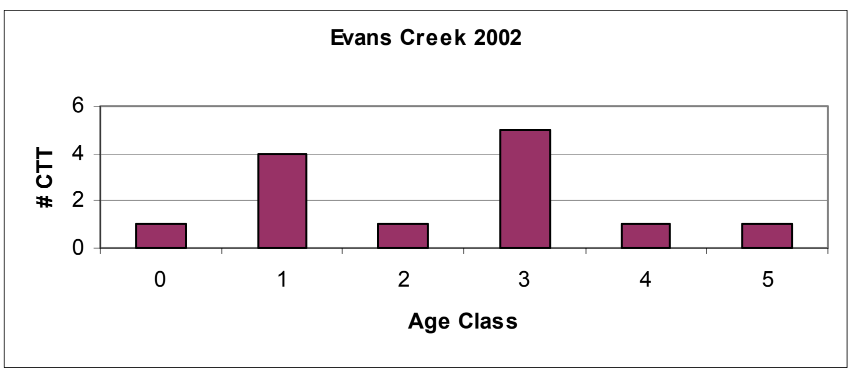
			Age Class								
Location	**Cohort**	**n=**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Alder	2001	3	62 (7)								
	2000	3	50 (15)	100 (14)							
Alder Total		**6**	**56 (12)**	**100 (14)**							
Benewah	2001	1	77								
	2000	3	79 (9)	116 (4)							
	1999	4	80 (5)	126 (10)	159 (14)						
	1998	0									
	1997	1	87	117	155	186	224				
Benewah Total		**9**	**80 (6)**	**121 (9)**	**158 (12)**	**186**	**224**				
Evans	2001	4	81 (9)								
	2000	1	65	112							
	1999	5	74 (6)	130 (11)	172 (10)						
	1998	1	74	135	186	247					
	1997	1	70	126	181	218	164				
Evans Total		**12**	**75 (8)**	**128 (11)**	**175 (10)**	**232 (21)**	**264**				
Lake	2001	1	44								
	2000	2	44 (4)	110 (11)							
	1999	8	48 (6)	106 (5)	159 (12)						
	1998	0									
	1997	1	47	103	140	186	233				
	1996	17	49 (6)	102 (8)	154 (11)	205 (16)	255 (16)	309 (21)			
	1995	33	52 (6)	101 (7)	149 (10)	198 (9)	248 (15)	295 (18)	347 (18)		
	1994	14	48 (7)	100 (11)	159 (16)	193 (17)	244 (23)	289 (21)	334 (26)	374 (27)	
	1993	1	45	90	128	165	203	248	278	315	353
Lake Total		**77**	**50 (6)**	**101 (8)**	**150 (12)**	**198 (14)**	**248 (18)**	**296 (21)**	**341 (23)**	**370 (30)**	**353**
Grand Total		**104**	**65 (15)**	**113 (14)**	**161 (13)**	**205 (24)**	**245 (20)**	**296 (21)**	**341 (23)**	**370 (30)**	**353**

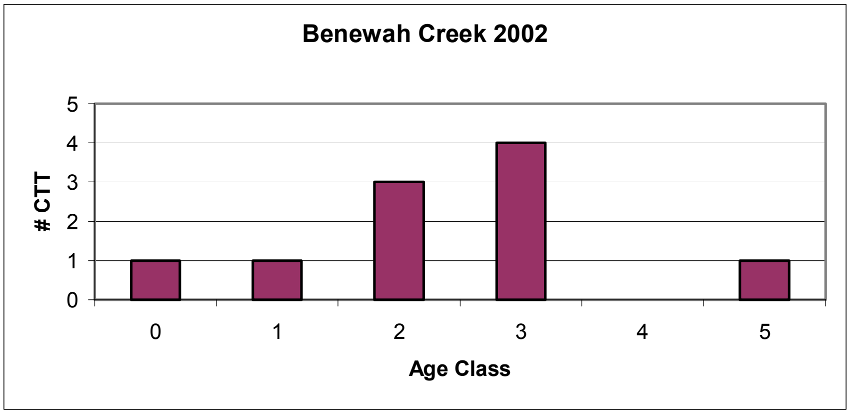
Table B-2. Mean back-calculated lengths at annulus formation by age class and cohort for eastern brook trout, 2002. Standard deviations are in parenthesis.

			Age Class		
Location	**Cohort**	**n=**	**1**	**2**	**3**
Alder	2001	10	66 (13)		
	2000	4	50 (8)	112 (10)	
	1999	5	46 (9)	103 (9)	149 (20)
Alder Total		**19**	**57 (14)**	**106 (10)**	**148 (20)**
Benewah	2001	2	52 (4)		
	2000	5	44 (9)	104 (13)	
	1999	1	41	103	155
Benewah Total		**8**	**45 (8)**	**103 (11)**	**155**
Grand Totals		**27**	**51 (8)**	**105 (2)**	**152 (5)**

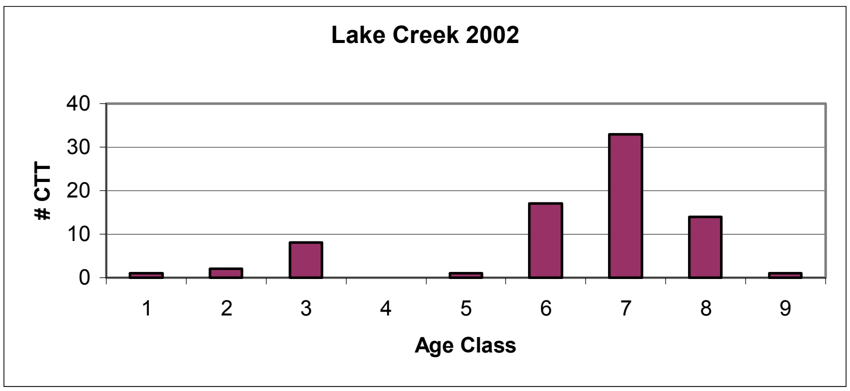
Table B-3. Age frequency distributions by watershed, 2002



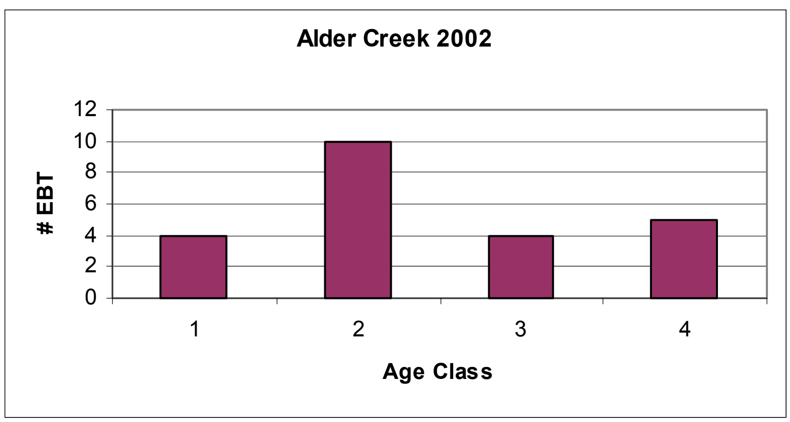




Benewah Creek 2002
CTT
5
4
3
2
1
0
0
1
2
3
4
5
Age Class



Lake Creek 2002
CTT
40
30
20
10
0
1
2
3
4
5
6
7
8
9
Age Class



Alder Creek 2002
EBT
12
10
8
6
4
2
0
1
2
3
4
Age Class

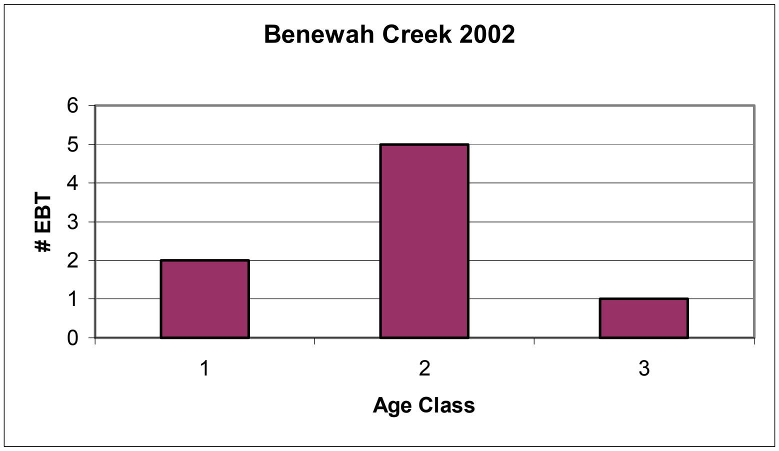
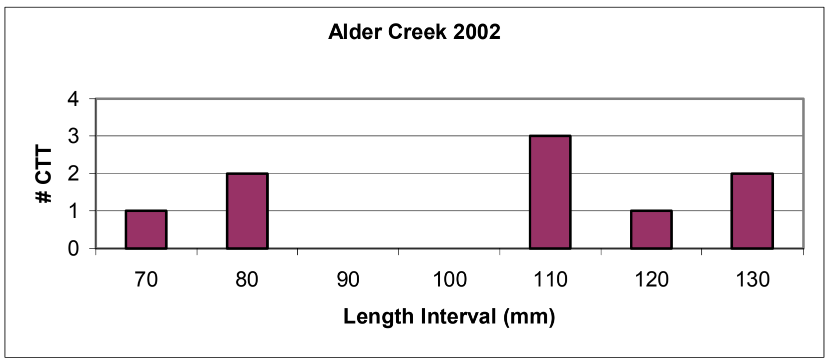
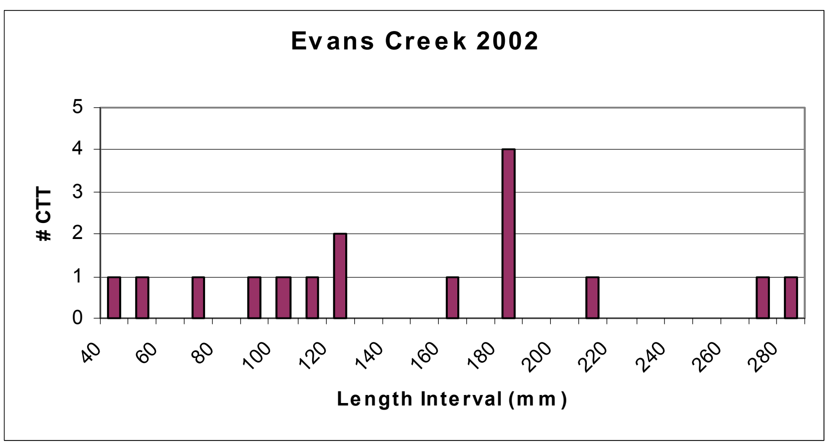
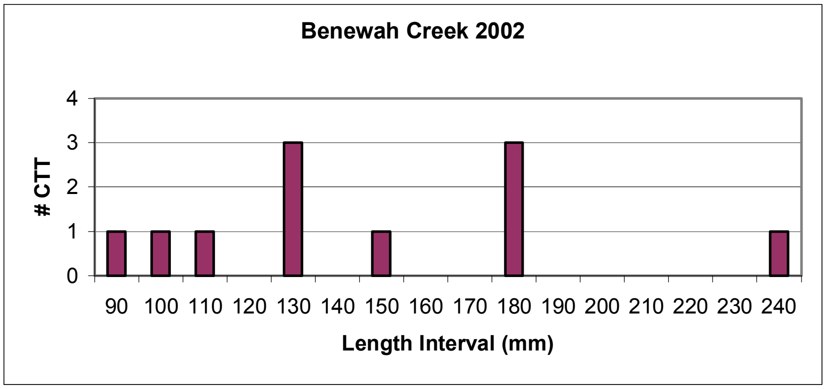
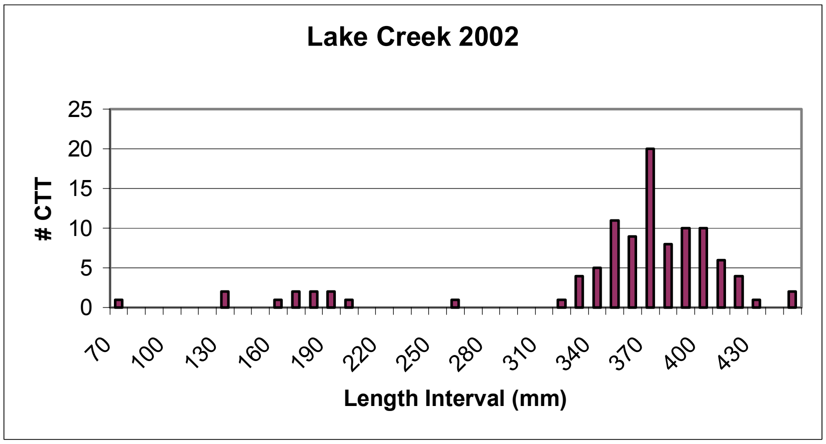


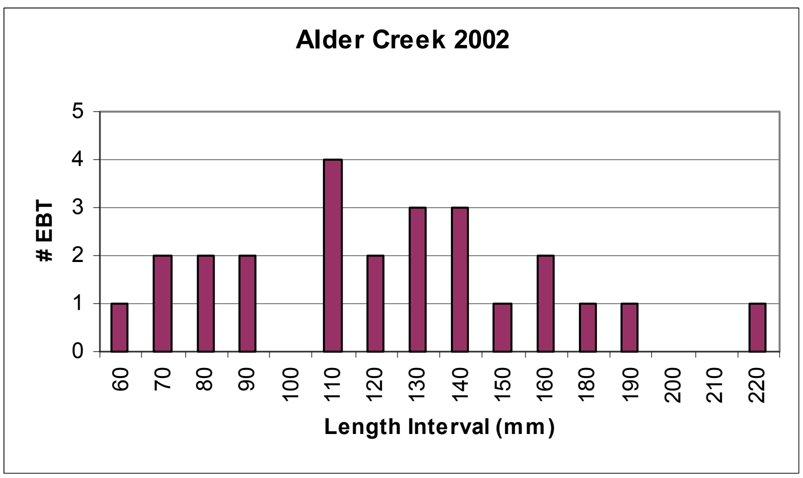
Table B-4. Length frequency distributions by watershed, 2002.

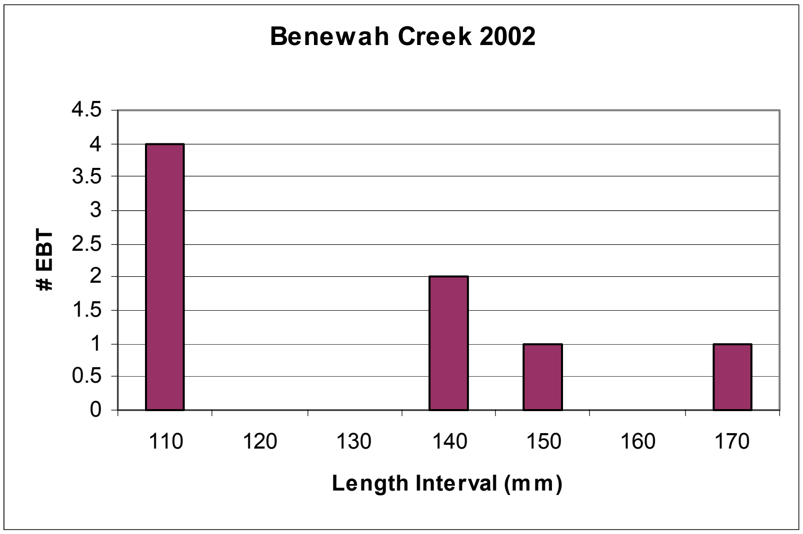





Benewah Creek 2002
CTT
0
1
2
3
4
90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240
Length Interval (mm)


Lake Creek 2002
CTT
0
5
10
15
20
25
70 100 130 160 190 220 250 280 310 340 370 400 430
Length Interval (mm)

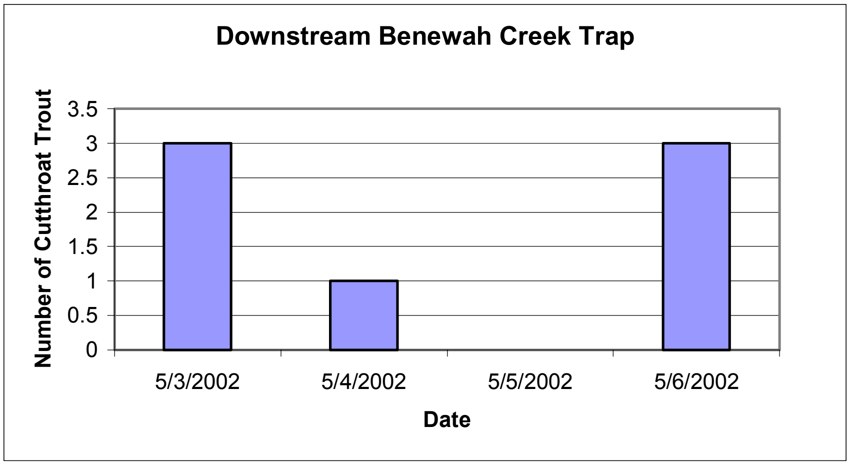

Alder Creek 2002
EBT
0
1
2
3
4
5
60 70 80 90 100 110 120 130 140 150 160 180 190 200 210 220
Length Interval (mm)

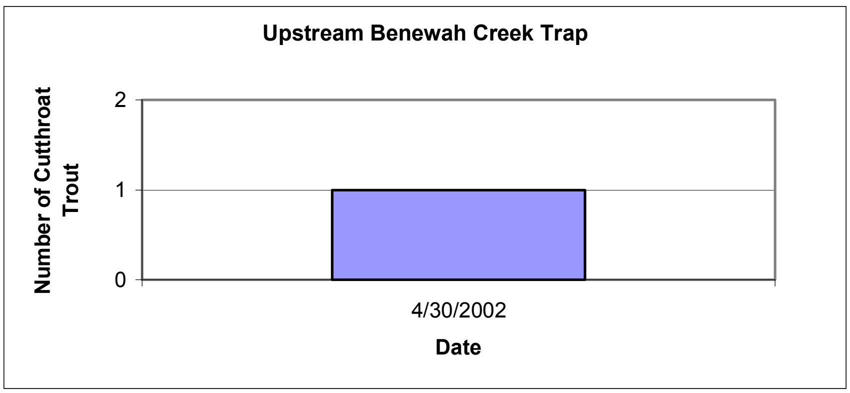


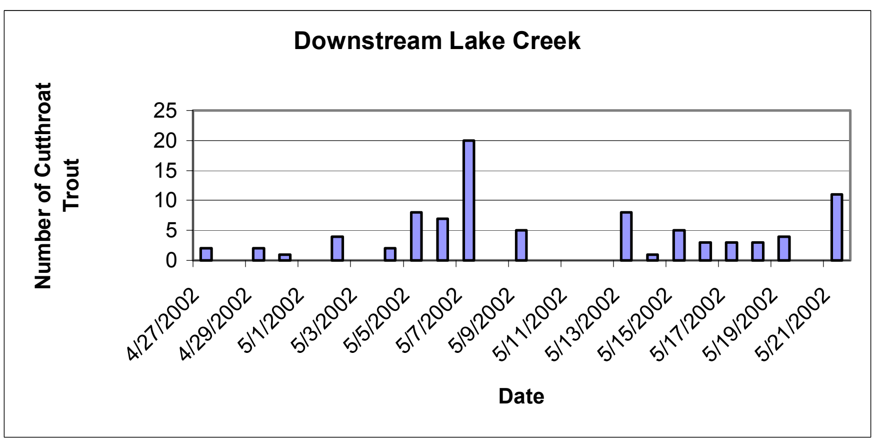
Benewah Creek 2002
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
EBT
110
120
130
140
150
160
170
Length Interval (mm)

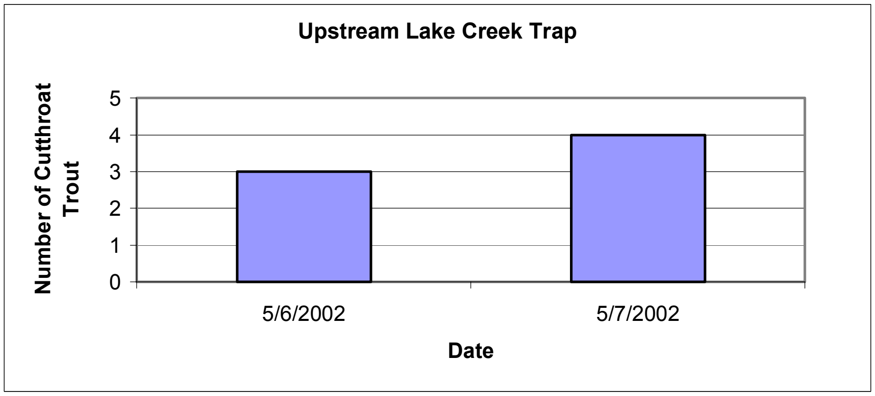
APPENDIX C

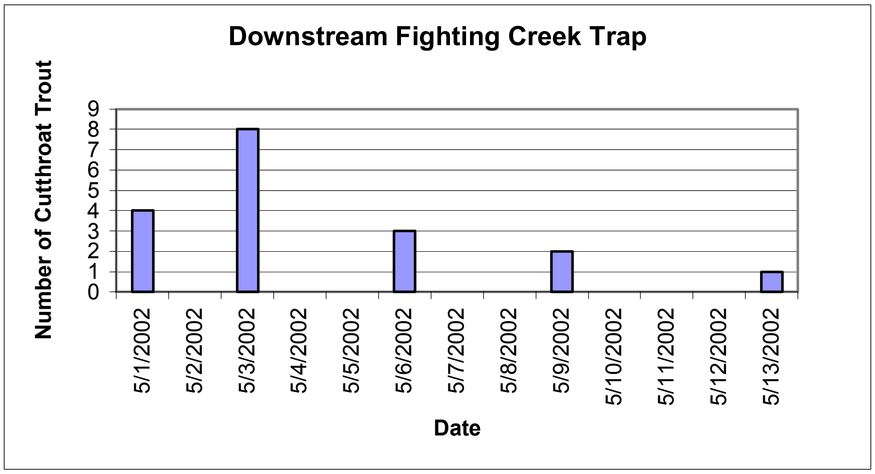
Cutthroat trout caught in individual traps, 2002.

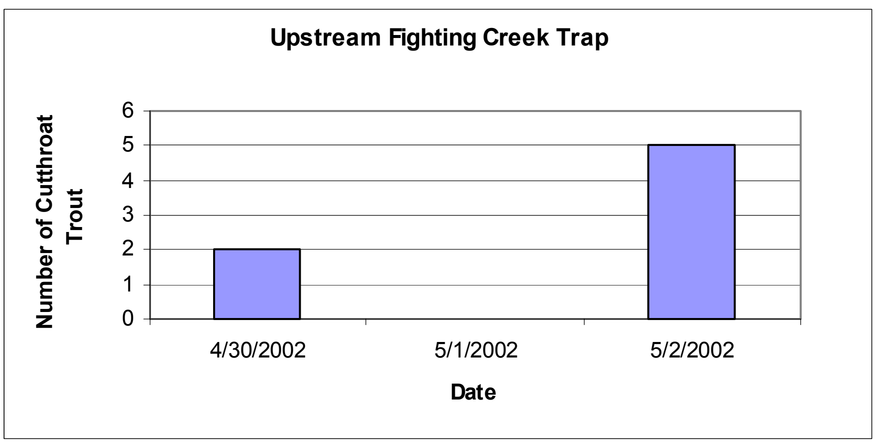

Downstream Benewah Creek Trap
Number of Cutthroat Trout
3.5
3
2.5
2
1.5
1
0.5
0
5/3/2002
5/4/2002
5/5/2002
5/6/2002
Date

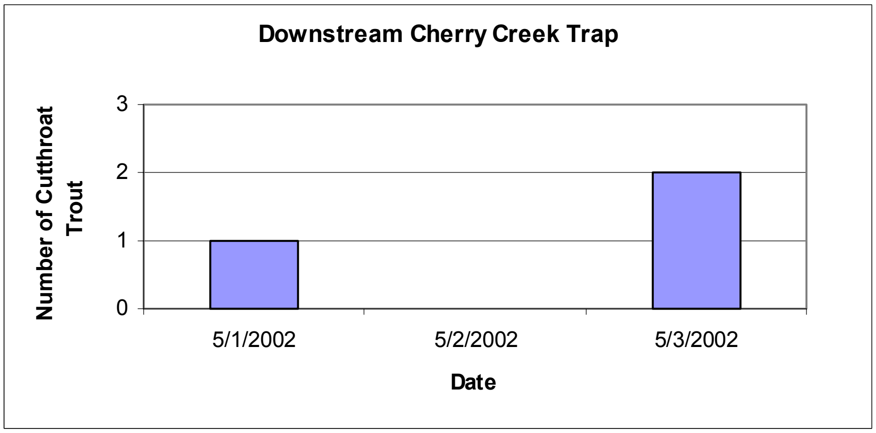

Upstream Benewah Creek Trap
Number of Cutthroat Trout
2
1
0
4/30/2002
Date


Downstream Lake Creek
Number of Cutthroat Trout
25
20
15
10
5
0
4/27/2002
4/29/2002
5/1/2002
5/3/2002
5/5/2002
5/7/2002
5/9/2002
5/11/2002
5/13/2002
5/15/2002
5/17/2002
5/19/2002
5/21/2002
Date


Upstream Lake Creek Trap
Number of Cutthroat Trout
5
4
3
2
1
0
5/6/2002
5/7/2002
Date


Downstream Fighting Creek Trap
Number of Cutthroat Trout
9
8
7
6
5
4
3
2
1
0
5/1/2002
5/2/2002
5/3/2002
5/4/2002
5/5/2002
5/6/2002
5/7/2002
5/8/2002
5/9/2002
5/10/2002
5/11/2002
5/12/2002
5/13/2002
Date


Upstream Fighting Creek Trap
Number of Cutthroat Trout
6
5
4
3
2
1
0
4/30/2002
5/1/2002
5/2/2002
Date


Downstream Cherry Creek Trap
Number of Cutthroat Trout
3
2
1
0
5/1/2002
5/2/2002
5/3/2002
Date

APPENDIX D

Lake and Stream Water Quality Data

Table D-1. 2002 Secchi Disk data for all Coeur d'Alene Tribe monitored lake stations.

Measurement units = meters nd = no data

Note: Since lake monitoring typically takes place over two to three days, the dates given below are the earliest date shown in the original data.

DATES --> LAKE SITES	4/25/02	5/11/02	7/29/02	8/30/02	9/18/02
09 Round Lake	nd	nd	nd	nd	nd
11 Chatcolet Lake shallow	nd	nd	nd	nd	nd
01 Rockford Bay	1.5	1.2	nd	8.4	7.7
02 Windy Bay shallow	2.1	nd	nd	7.0	6.2
06 Carey Bay	nd	nd	nd	8.8	6.2
03 Windy Bay deep	1.5	1.7	nd	9.9	7.5
05 University Pt.	1.0	2.1	nd	10.9	7
07 Conkling Park	nd	1.9	nd	7.5	5.5
08 Hidden Lake	nd	nd	nd	5.0	4.5
10 Chatcolet Lake deep	nd	2.0	1.8	6.6	2.5
12 Benewah Lake	nd	nd	3.2	2.9	2.5
04 Coeur d'Alene River	1	2.2	nd	nd	5.5
13 St. Joe River	nd	nd	2.9	3.9	1.9

Table D-2. 2002 Temperature data for all Coeur d'Alene Tribe monitored lake stations.

Measurement units = degrees C nd = no data

Note: Since lake monitoring typically takes place over two to three days, the dates given below are the earliest date shown in the original data.

DATES -->	4/25/02		5/11/02		7/29/02		8/30/02		9/18/02	
LAKE SITES	Mean	Range (S-B)	Mean	Range (S-B)	Mean	Range (S-B)	Mean	Range (S-B)	Mean	Range (S-B)
09 Round Lake	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
11 Chatcolet Lake shallow	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
01 Rockford Bay	5.2	7.17-4.59	7.1	8.55-6.76	nd	nd	19.4	21.27-15.24	17.9	18.14-17.44
02 Windy Bay shallow	5.3	7.05-5.01	7.3	8.55-6.53	nd	nd	17.9	21.27-11.25	17.2	17.96-14.27
06 Carey Bay	nd	nd	nd	nd	nd	nd	18.8	20.50-14.33	17.1	17.76-14.76
03 Windy Bay deep	5.4	6.91-5.13	6.8	8.14-6.00	nd	nd	nd	nd	15.0	20.55-7.17
05 University Pt.	6.4	9.14-4.98	6.9	8.88-5.60	nd	nd	12.9	20.88-7.02	17.4	18.1-12.18
07 Conkling Park	nd	nd	6.8	8.14-5.92	nd	nd	18.6	20.67-13.14	16.1	17.53-9.95
08 Hidden Lake	nd	nd	nd	nd	nd	nd	18.6	21.47-14.07	16.3	17.44-13.26
10 Chatcolet Lake deep	nd	nd	6.9	8.53-5.84	16.4	21.44-10.06	17.2	21.42-11.03	16.4	17.68-12.40
12 Benewah Lake	nd	nd	nd	nd	21.0	22.81-16.26	20.5	22.47-19.09	16.4	17.22-16.16
04 Coeur d'Alene River	7.2	8.16-6.74	8.7	9.35-7.81	nd	nd	nd	nd	17.6	17.92-17.08
13 St. Joe River	nd	nd	nd	nd	20.6	20.90-20.35	19.3	20.42-18.97	17.0	17.82-16.89

Table D-3. 2002 Dissolved Oxygen data for all Coeur d'Alene Tribe monitored lake stations.

Measurement units = mg/L nd = no data

Note: Since lake monitoring typically takes place over two to three days, the dates given below are the earliest date shown in the original data.

DATES -->	4/25/02		5/11/02		7/29/02		8/30/02		9/18/02	
LAKE SITES	Mean	Range (H-L)	Mean	Range (H-L)	Mean	Range (H-L)	Mean	Range (H-L)	Mean	Range (H-L)
09 Round Lake	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
11 Chatcolet Lake shallow	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
01 Rockford Bay	9.70	9.81-9.49	7.1	8.55-6.74	nd	nd	8.9	9.82-8.55	8.9	9.07-8.46
02 Windy Bay shallow	9.61	9.72-9.51	7.3	8.55-6.53	nd	nd	8.0	8.96-0.00	8.7	9.32-5.46
06 Carey Bay	nd	nd	nd	nd	nd	nd	8.3	8.87-6.34	8.4	9.26-4.77
03 Windy Bay deep	9.43	9.55-9.16	11.7	12.02-11.40	nd	nd	8.4	9.04-7.34	8.8	9.12-8.26
05 University Pt.	9.39	9.83-8.92	11.6	11.9-11.25	nd	nd	8.5	9.04-7.62	9.1	9.48-8.41
07 Conkling Park	nd	nd	11.3	12.04-10.94	nd	nd	7.9	8.75-5.25	8.1	9.59-3.31
08 Hidden Lake	nd	nd	nd	nd	nd	nd	5.4	8.89-.17	7.5	8.97-.16
10 Chatcolet Lake deep	nd	nd	11.9	12.61-11.42	7.5	9.62-2.61	5.1	8.93-.11	6.2	8.86-0.07
12 Benewah Lake	nd	nd	nd	nd	7.3	8.61-1.65	5.6	9.88-.39	7.9	8.35-6.83
04 Coeur d'Alene River	9.32	9.39-9.20	11.4	11.88-11.18	nd	nd	nd	nd	8.6	8.78-7.75
13 St. Joe River	nd	nd	nd	nd	8.1	8.25-7.9	8.0	8.49-7.68	8.7	8.78-8.47

Table D-4. 2002 pH data for all Coeur d'Alene Tribe monitored lake stations.

Measurement units = pH units nd = no data

Note: Since lake monitoring typically takes place over two to three days, the dates given below are the earliest date shown in the original data.

DATES -->	4/25/02		5/11/02		7/29/02		8/30/02		9/18/02	
LAKE SITES	Mean	Range (H-L)	Mean	Range (H-L)	Mean	Range (H-L)	Mean	Range (H-L)	Mean	Range (H-L)
09 Round Lake	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
11 Chatcolet Lake shallow	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
01 Rockford Bay	7.00	7.02-6.95	7.2	7.31-7.11	nd	nd	7.4	7.59-6.79	7.2	7.28-6.97
02 Windy Bay shallow	7.02	7.07-6.91	7.2	7.31-7.09	nd	nd	6.8	7.69-6.54	7.1	7.38-6.53
06 Carey Bay	nd	nd	nd	nd	nd	nd	7.2	7.59-6.47	7.2	7.4-6.58
03 Windy Bay deep	7.01	7.03-6.99	7.1	7.28-7.05	nd	nd	6.9	7.67-6.42	7.1	7.38-6.33
05 University Pt.	6.94	7.01-6.88	7.1	7.25-6.98	nd	nd	6.9	7.66-6.43	7.2	7.4-6.46
07 Conkling Park	nd	nd	7.4	9.89-6.9	nd	nd	7.2	7.58-6.57	7.0	7.38-5.99
08 Hidden Lake	nd	nd	nd	nd	nd	nd	7.5	8.59-6.5	7.3	7.42-6.57
10 Chatcolet Lake deep	nd	nd	7.1	7.16-7.03	7.4	8.62-6.07	7.6	8.73-6.45	7.2	7.66-6.42
12 Benewah Lake	nd	nd	nd	nd	7.3	7.72-6.22	7.5	8.72-6.43	6.7	6.84-6.55
04 Coeur d'Alene River	6.90	6.92-6.88	7.1	7.14-7.02	nd	nd	nd	nd	7.2	7.32-6.93
13 St. Joe River	nd	nd	nd	nd	6.9	7.00-6.73	7.0	7.2-6.95	7.0	7.05-6.93

Table D-5. 2002 Conductivity data for all Coeur d'Alene Tribe monitored lake stations.

Measurement units = us/cm nd = no data

Note: Since lake monitoring typically takes place over two to three days, the dates given below are the earliest date shown in the original data.

DATES -->	4/25/02		5/11/02		7/29/02		8/30/02		9/18/02	
LAKE SITES	Mean	Range (H-L)	Mean	Range (H-L)	Mean	Range (H-L)	Mean	Range (H-L)	Mean	Range (H-L)
09 Round Lake	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
11 Chatcolet Lake shallow	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
01 Rockford Bay	46.6333333	47.2-45.4	44.8	46.1-44	nd	nd	40.2	41.5-36.6	18.2	18.4-18
02 Windy Bay shallow	46.69375	47.8-44.6	45.2	48.2-42.8	nd	nd	38.2	42.5-37.8	18.5	20.5-16.8
06 Carey Bay	nd	nd	nd	nd	nd	nd	41.9	44.3-37.5	23.7	48.1-19.8
03 Windy Bay deep	45.7466667	46.6-44.9	44.3	48.7-39.7	nd	nd	40.9	43.6-35.8	19.1	20.3-16.4
05 University Pt.	39.56875	45.0-34.2	45.6	50.2-40.8	nd	nd	41.8	47.3-36.1	18.8	19.2-16.7
07 Conkling Park	nd	nd	42.3	48.3-37.5	nd	nd	42.6	45.6-37.7	22.4	23.5-19
08 Hidden Lake	nd	nd	nd	nd	nd	nd	56.125	136.7-40.1	33.2	118.7-21.7
10 Chatcolet Lake deep	nd	nd	38.4	39.3-38.3	25.5	28.5-22.2	50.3	120.7-39.6	24.0	33.4-22.3
12 Benewah Lake	nd	nd	nd	nd	29.0	36.3-27.4	79.5	150.3-42.8	23.1	23.2-23
04 Coeur d'Alene River	35	35.6-34.4	43.2	44.8-41.6	nd	nd	nd	nd	25.0	28.2-23.2
13 St. Joe River	nd	nd	nd	nd	32.1	32.3-31.7	53.7	54.1-53.5	27.8	27.9-27.7

Table D-6. 2002 Compiled stream flow data for Coeur d'Alene Tribe monitored stream stations.

Measurement units = cubic feet per second (cfs)   nd = no data

Note: Since monitoring typically takes place over two to three days, the dates given below are the earliest date shown in the original data.

DATES -->	**3/13/02**	**5/14/02**	**6/7/02**	**7/11/02**	**8/2/02**	**8/22/02**	**9/5/02**	**10/22/02**	**11/14/02**
STREAM SITES									
Alder Cr.	46.62	29.86	7.84	1.86	0.82	8.35	0.70	0.86	8.76
N. Fork Alder Cr	13.14	17.41	3.12	0.74	0.60	2.79	0.44	0.50	3.48
Upper Benewah	nd	13.85	nd	0.96	nd	1.34	nd	0.33	2.28
Three Mile Benewah	nd	28.87	10.21	3.14	1.88	7.77	1.11	0.91	nd
Nine Mile Benewah Cr.	nd	22.09	7.25	1.89	0.82	5.78	0.52	0.50	nd
W. Fork Benewah	nd	4.28	nd	nd	nd	0.48	nd	0.16	1.16
Schoolhouse Cr.	nd	0.79	nd	nd	0.50	0.62	0.30	0.05	0.85
Whitetail Cr.	nd	2.20	nd	0.11	nd	nd	nd	nd	nd
Windfall Cr.	nd	1.16	nd	0.31	0.02	0.53	0.02	0.05	nd
Evans Cr	nd	36.68	38.98	5.18	3.12	3.03	1.76	1.65	1.81
Upper Evans Cr.	nd	30.26	35.99	5.28	3.00	2.01	1.73	1.02	1.33
E. Fork Evans Cr.	nd	6.78	1.99	0.68	0.28	0.35	0.22	0.16	0.19
Upper Lake Cr.	nd	nd	nd	nd	nd	nd	nd	nd	nd
Lower Lake Cr.	nd	46.84	13.07	4.90	1.14	0.39	0.51	0.58	nd
Bozard Cr.	nd	19.77	5.13	3.48	0.60	nd	nd	nd	nd

Table D-7. 2002 Compiled stream Temperature data for Coeur d'Alene Tribe monitored stream stations.

Measurement units = degrees C   nd = no data

Note: Since monitoring typically takes place over two to three days, the dates given below are the earliest date shown in the original data.

DATES -->	**3/13/02**	**5/14/02**	**6/7/02**	**7/11/02**	**8/2/02**	**8/22/02**	**9/5/02**	**10/22/02**	**11/14/02**
STREAM SITES									
Alder Cr.	1.52	7.00	8.27	20.89	18.82	13.44	14.61	6.17	0.14
N. Fork Alder Cr	1.74	0.95	7.55	18.56	15.96	12.94	13.08	3.44	1.34
Upper Benewah	nd	5.79	nd	16.32	nd	11.62	nd	2.58	4.06
Three Mile Benewah	nd	9.20	11.59	18.21	14.33	19.18	13.58	-0.09	nd
Nine Mile Benewah Cr.	2.37	6.62	9.05	18.42	16.32	15.34	14.68	1.40	nd
W. Fork Benewah	nd	6.26	nd	17.17	nd	12.43	nd	2.42	3.78
Schoolhouse Cr.	nd	6.70	nd	14.50	12.59	12.05	12.22	1.70	1.30
Whitetail Cr.	nd	5.41	nd	15.15	13.53	13.04	12.35	2.25	nd
Windfall Cr.	nd	nd	nd	17.31	14.65	13.72	13.38	1.36	nd
Evans Cr	nd	6.71	7.05	14.09	12.42	13.08	11.83	6.43	3.38
Upper Evans Cr.	nd	5.48	6.08	11.03	10.27	11.28	10.25	5.31	2.84
E. Fork Evans Cr.	nd	5.61	8.14	12.17	11.20	12.47	9.79	5.73	3.38
Upper Lake Cr.	nd	11.90	11.04	14.35	nd	14.99	9.50	3.94	nd
Lower Lake Cr.	nd	5.84	14.56	16.88	18.87	19.81	10.38	4.35	nd
Bozard Cr.	nd	10.15	9.69	14.05	14.75	15.12	8.91	3.36	nd

Table D-8. 2002 Compiled stream Dissolved Oxygen data for Coeur d'Alene Tribe monitored stream stations.

Measurement units = mg/L　　　　nd = no data

Note: Since monitoring typically takes place over two to three days, the dates given below are the earliest date shown in the original data.

DATES -->	3/13/02	5/14/02	6/7/02	7/11/02	8/2/02	8/22/02	9/5/02	10/22/02	11/14/02
STREAM SITES									
Alder Cr.	12.55	14.60	11.90	9.08	11.61	9.44	11.62	12.35	13.31
N. Fork Alder Cr	12.59	13.06	12.14	9.13	11.70	9.51	11.04	12.06	13.18
Upper Benewah	nd	11.25	nd	9.17	nd	10.02	nd	12.51	12.15
Three Mile Benewah	nd	10.12	10.21	8.99	10.37	8.68	11.26	13.92	nd
Nine Mile Benewah Cr.	nd	12.52	11.36	8.21	9.78	9.11	10.17	12.48	nd
W. Fork Benewah	nd	11.25	nd	9.02	nd	9.47	nd	12.28	12.14
Schoolhouse Cr.	nd	10.85	nd	8.74	9.04	9.04	7.54	9.35	12.29
Whitetail Cr.	nd	11.05	nd	8.45	7.65	7.61	6.60	7.51	nd
Windfall Cr.	nd	nd	nd	8.11	9.30	9.17	8.80	11.71	nd
Evans Cr	nd	11.26	13.00	9.76	10.07	9.89	11.12	11.14	12.68
Upper Evans Cr.	nd	13.93	10.28	10.48	10.86	10.43	11.43	11.59	13.09
E. Fork Evans Cr.	nd	11.98	10.51	10.17	10.56	10.13	11.00	11.44	12.89
Upper Lake Cr.	nd	10.36	10.03	9.13	8.31	7.70	9.20	10.66	nd
Lower Lake Cr.	nd	13.12	9.96	9.82	9.86	8.91	10.82	12.06	nd
Bozard Cr.	nd	10.51	11.31	9.26	8.62	7.48	9.42	10.68	nd

Table D-9. 2002 Compiled stream pH data for Coeur d'Alene Tribe monitored stream stations.

Measurement units = pH units　　　　nd = no data

Note: Since monitoring typically takes place over two to three days, the dates given below are the earliest date shown in the original data.

DATES -->	**3/13/02**	**5/14/02**	**6/7/02**	**7/11/02**	**8/2/02**	**8/22/02**	**9/5/02**	**10/22/02**	**11/14/02**
STREAM SITES									
Alder Cr.	6.70	6.60	7.00	9.10	7.80	6.98	7.81	7.59	7.01
N. Fork Alder Cr	6.60	6.37	6.96	8.89	7.55	6.93	7.36	7.31	6.86
Upper Benewah	nd	6.22	nd	8.41	nd	6.36	nd	7.09	6.81
Three Mile Benewah	nd	6.98	7.19	8.75	7.96	7.68	7.57	7.21	nd
Nine Mile Benewah Cr.	6.56	6.50	6.86	8.45	7.00	6.71	6.98	7.11	nd
W. Fork Benewah	nd	6.41	nd	8.41	nd	6.48	nd	6.96	6.60
Schoolhouse Cr.	nd	6.58	nd	8.36	6.77	6.50	6.51	6.81	6.58
Whitetail Cr.	nd	6.61	nd	8.37	6.79	6.68	6.75	6.75	nd
Windfall Cr.									
Evans Cr	nd	6.41	6.18	6.33	6.35	6.28	6.34	6.78	6.34
Upper Evans Cr.	nd	6.31	6.28	6.45	6.32	6.42	6.63	6.88	6.75
E. Fork Evans Cr.	nd	6.53	6.72	6.45	6.78	6.77	6.38	7.11	6.86
Upper Lake Cr.	nd	6.42	6.36	6.31	6.39	6.31	6.32	6.65	nd
Lower Lake Cr.	nd	6.33	6.97	7.13	7.56	7.34	7.07	7.26	nd
Bozard Cr.	nd	6.53	6.58	6.59	6.44	6.36	6.35	6.68	nd

Table D-10. 2002 Compiled stream Conductivity data for Coeur d'Alene Tribe monitored stream stations.

Measurement units = us/cm nd = no data

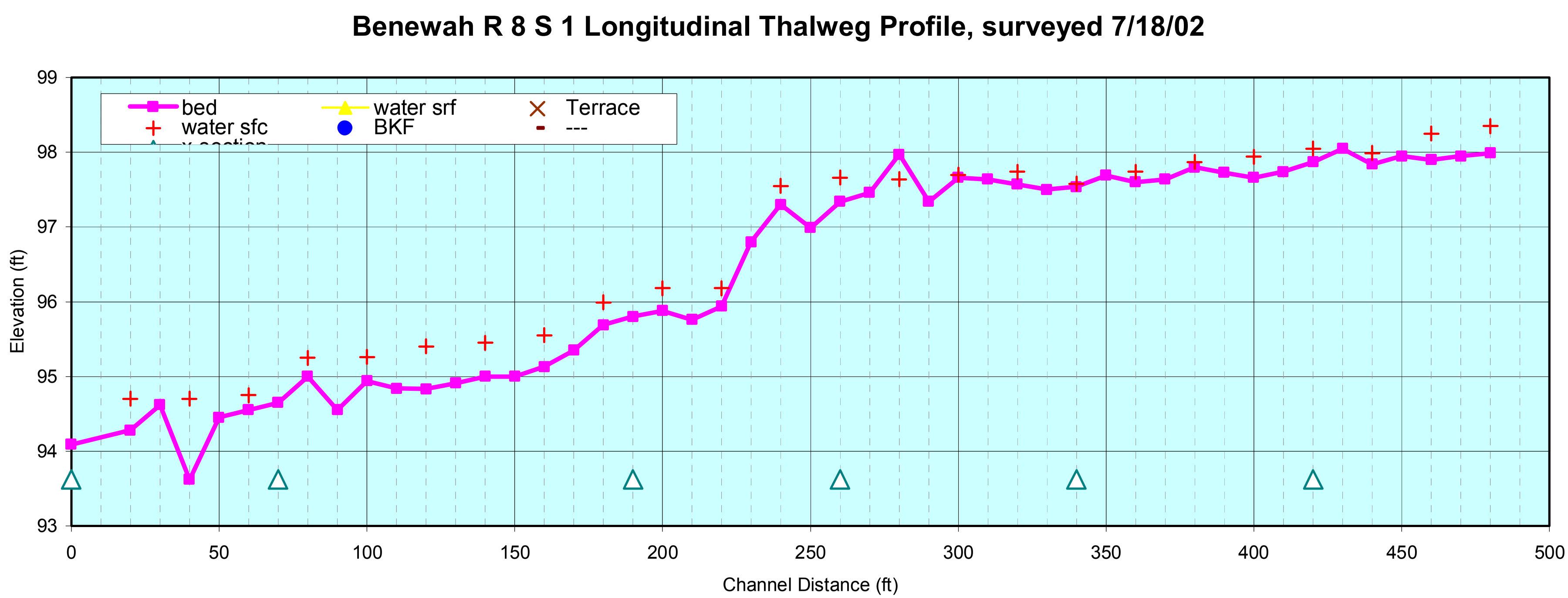
Note: Since monitoring typically takes place over two to three days, the dates given below are the earliest date shown in the original data.

DATES -->	3/13/02	5/14/02	6/7/02	7/11/02	8/2/02	8/22/02	9/5/02	10/22/02	11/14/02
STREAM SITES									
Alder Cr.	18.20	13.50	36.40	40.90	37.90	24.30	38.20	75.20	29.60
N. Fork Alder Cr	16.70	22.20	28.40	31.50	30.90	20.00	31.50	61.60	23.60
Upper Benewah	nd	10.00	nd	16.30	nd	12.00	nd	22.20	16.80
Three Mile Benewah	nd	14.10	29.10	31.90	25.70	20.10	26.30	37.10	nd
Nine Mile Benewah Cr.	17.50	12.80	26.80	28.40	24.40	18.60	25.90	35.70	nd
W. Fork Benewah	nd	11.30	nd	18.80	nd	16.10	nd	20.90	24.80
Schoolhouse Cr.	nd	16.20	nd	29.30	27.50	17.00	31.40	42.10	20.20
Whitetail Cr.	nd	27.30	nd	32.30	53.90	32.80	67.70	67.40	nd
Windfall Cr.	nd	nd	nd	29.40	28.60	19.00	30.20	39.70	nd
Evans Cr	nd	10.00	7.10	12.80	8.80	9.50	10.70	26.70	12.00
Upper Evans Cr.	nd	8.60	5.90	10.40	7.20	8.10	14.70	22.40	10.00
E. Fork Evans Cr.	nd	7.30	12.00	18.00	11.90	12.90	9.30	36.00	15.40
Upper Lake Cr.	nd	11.20	20.50	24.50	24.30	15.00	15.90	33.60	nd
Lower Lake Cr.	nd	18.00	25.70	26.60	33.10	26.90	35.50	69.60	nd
Bozard Cr.	nd	12.80	23.20	23.60	25.20	16.90	17.70	38.60	nd

APPENDIX E

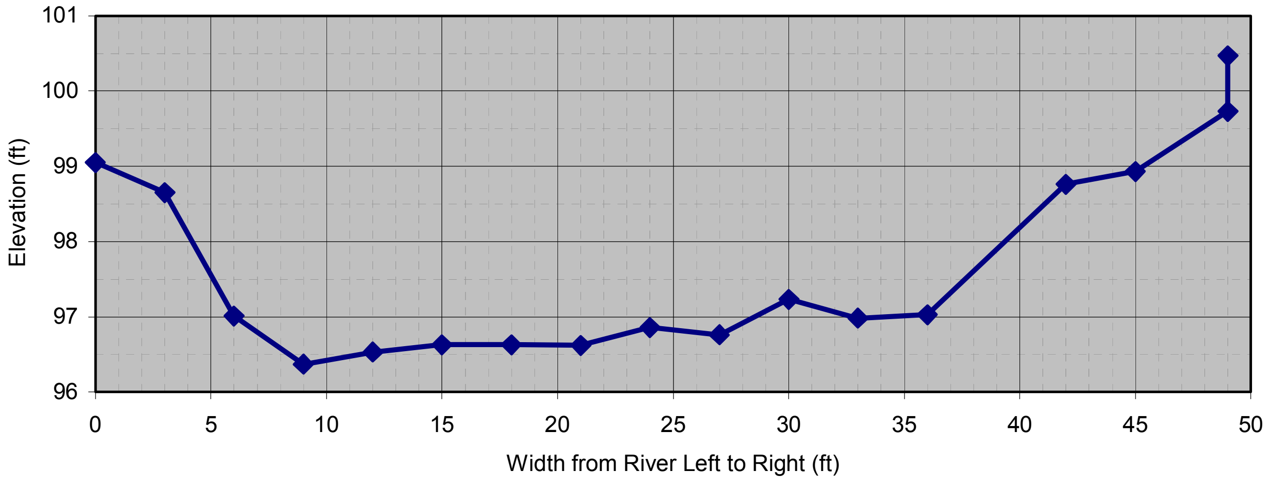
Stream Physical Habitat Monitoring Data:

Channel Profiles
Channel Pebble Counts and Graphs
Channel Canopy Cover

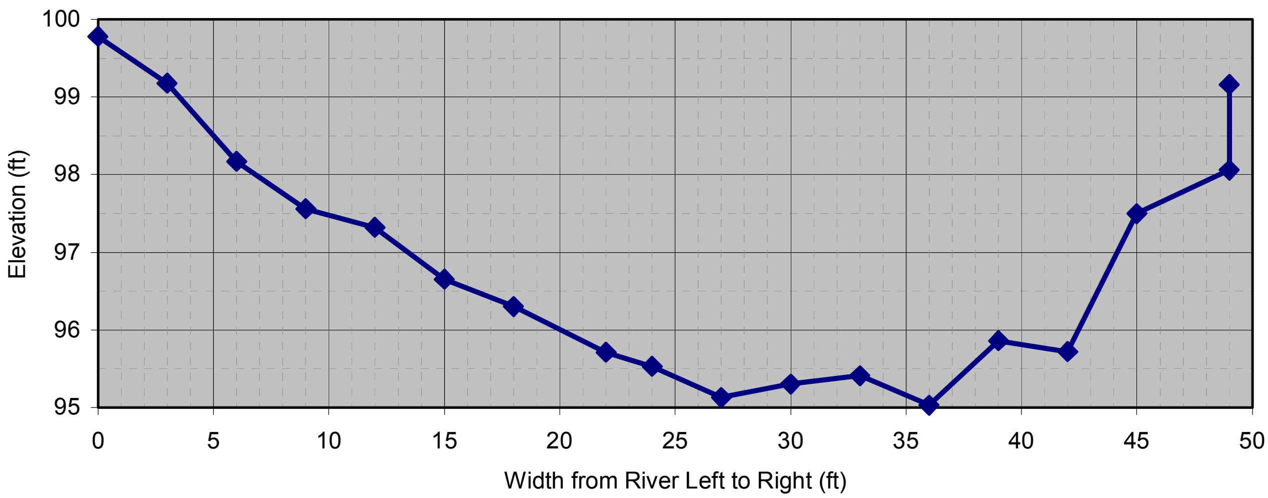

Benewah R 8 S 1 Longitudinal Thalweg Profile, surveyed 7/18/02
bed
water sfc
water srf
BKF
Terrace

Elevation (ft)
99
98
97
96
95
94
93
0
50
100
150
200
250
300
350
400
450
500
Channel Distance (ft)

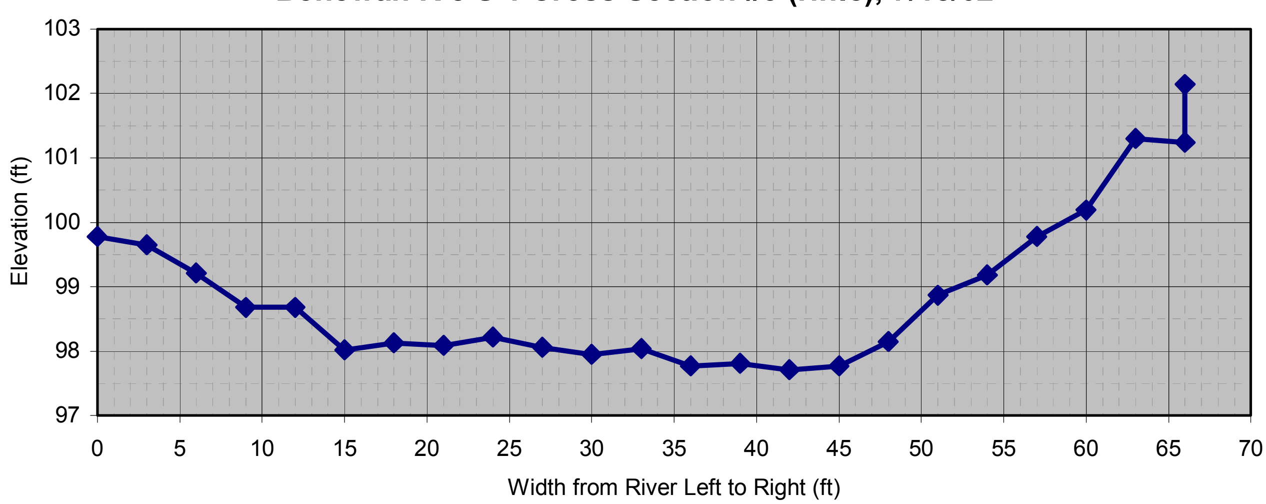
Benewah R 8 S 1 Cross Section #1 (pool), 7/18/02

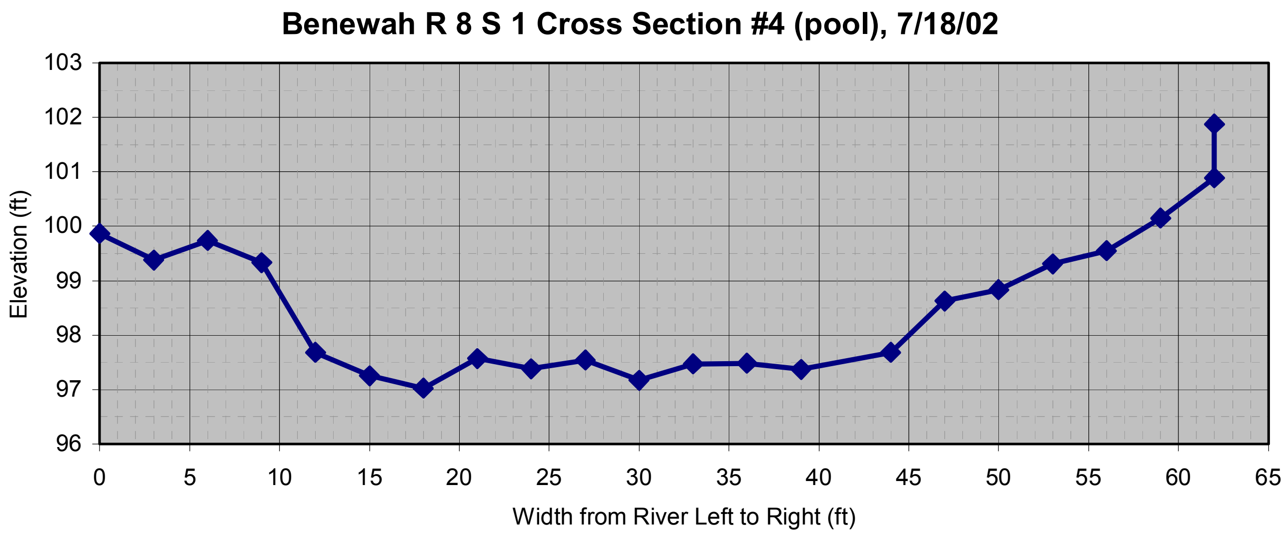


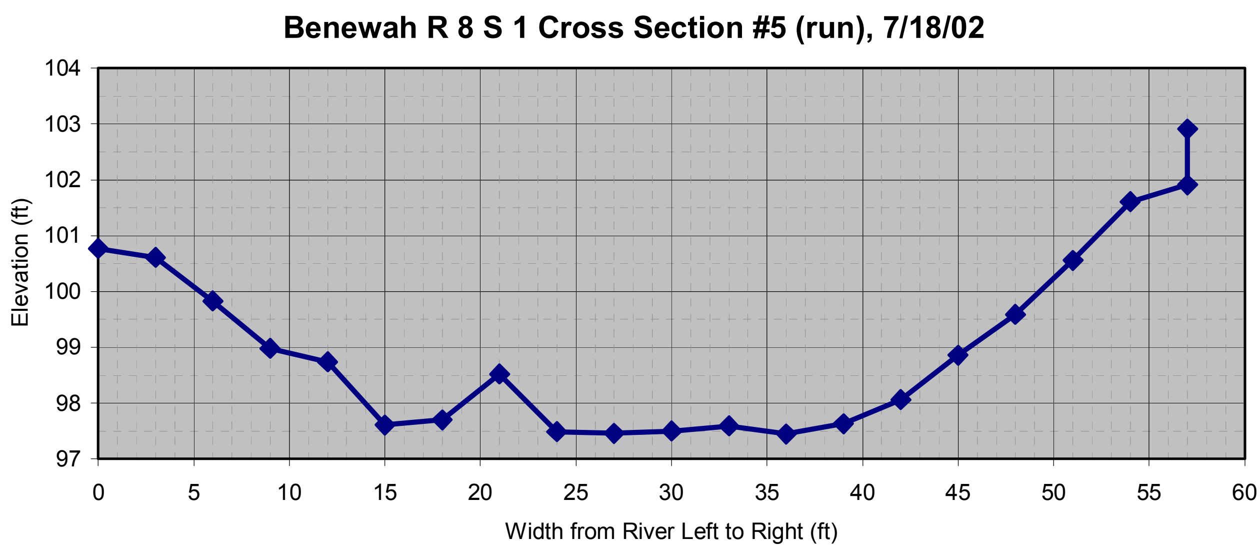
Benewah R 8 S 1 Cross Section #2 (riffle), 7/18/02

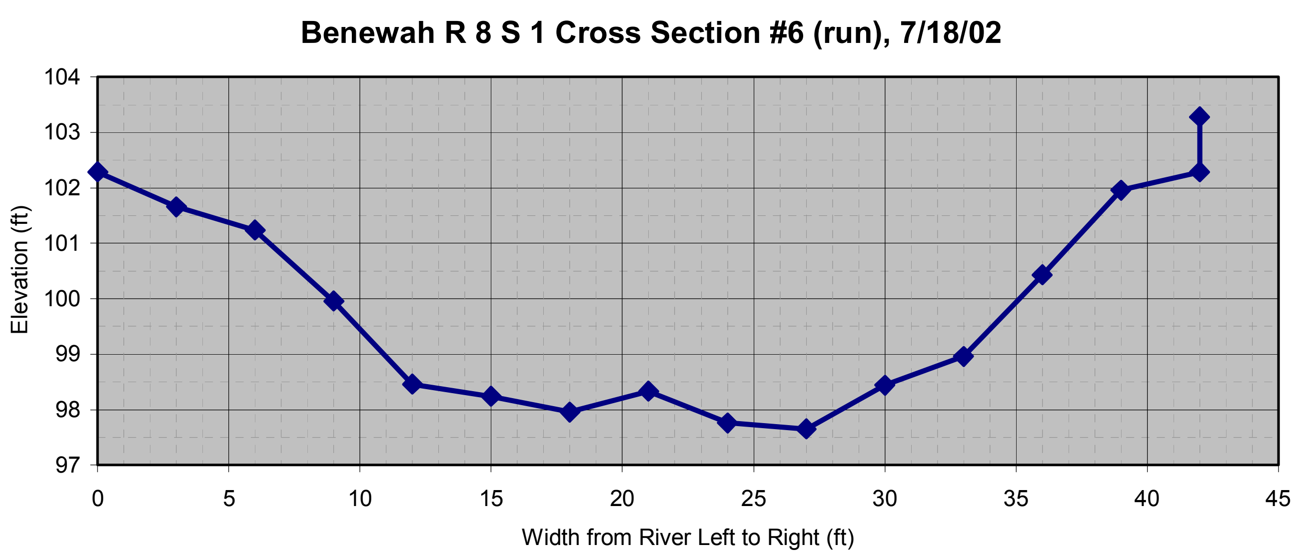


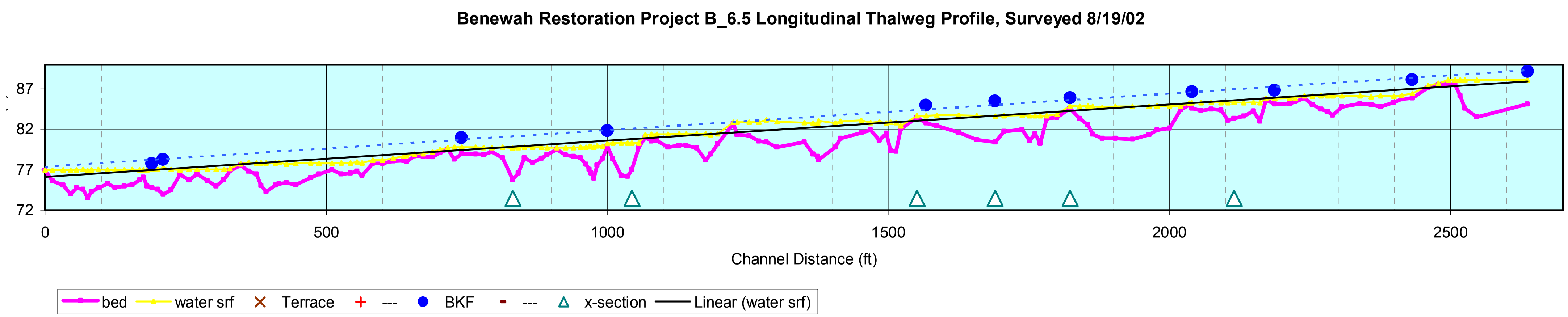
Benewah R 8 S 1 Cross Section #3 (riffle), 7/18/02




Benewah R 8 S 1 Cross Section #4 (pool), 7/18/02
Elevation (ft)
Width from River Left to Right (ft)

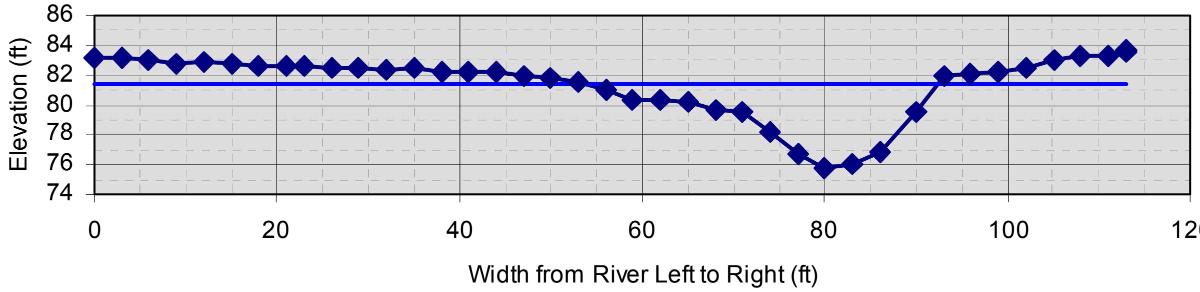

Benewah R 8 S 1 Cross Section #5 (run), 7/18/02
Elevation (ft)
Width from River Left to Right (ft)


Benewah R 8 S 1 Cross Section #6 (run), 7/18/02
Elevation (ft)
Width from River Left to Right (ft)

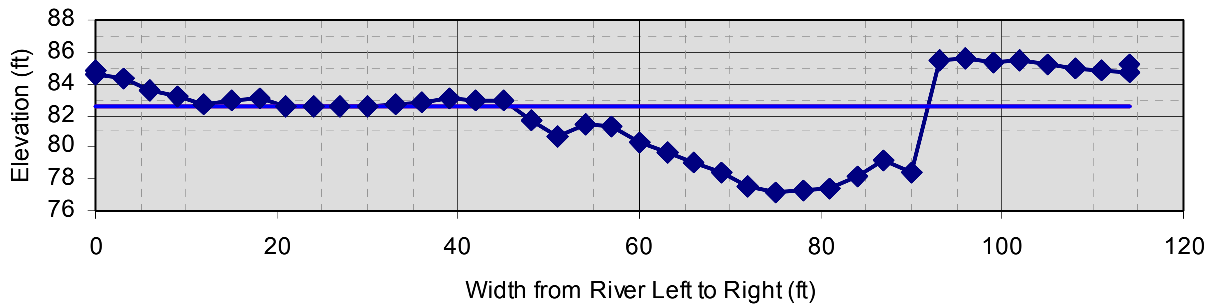

Benewah Restoration Project B_6.5 Longitudinal Thalweg Profile, Surveyed 8/19/02
87
82
77
72
0
500
1000
1500
2000
2500
Channel Distance (ft)
bed
water srf
Terrace

BKF
---
x-section
Linear (water srf)

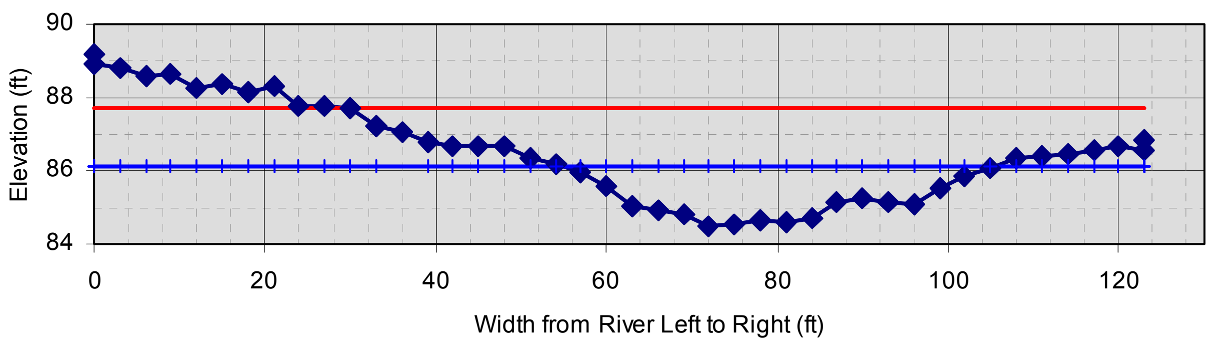
Benewah Restoration Project B_6.5 Cross Section #1 (Sta 8+32, Pool), 8/19/02



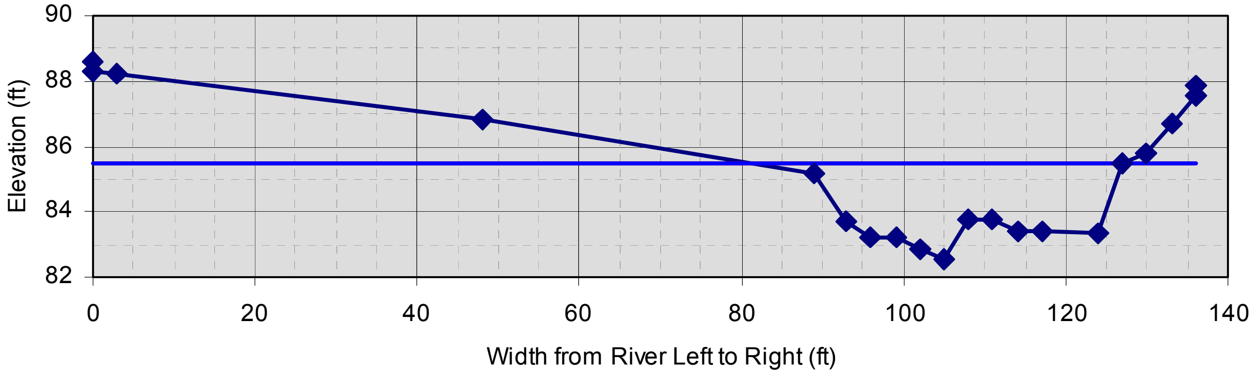
Benewah Restoration Project B_6.5 Cross Section #2 (Sta 10+44, Pool), 8/19/02.



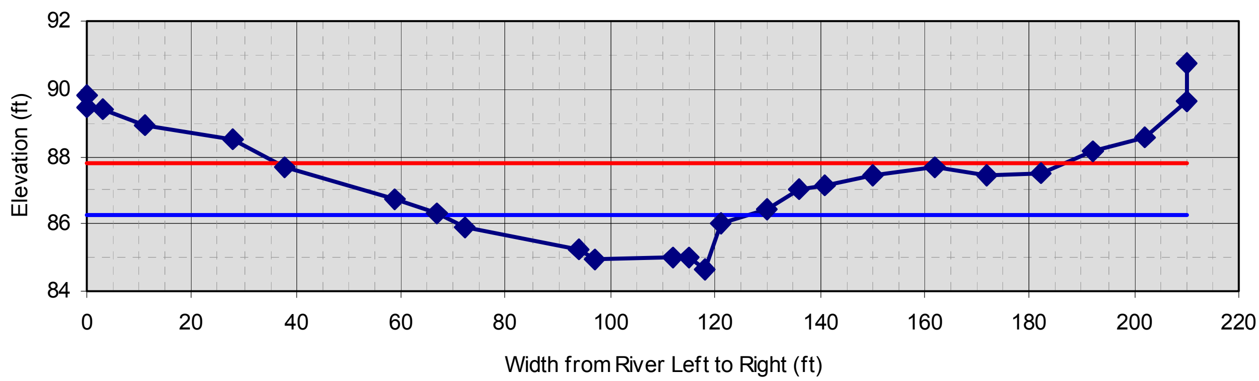
Benewah Restoratoin Project B_6.5 Cross Section #3 (Sta 15+51, Riffle), 8/19/02.



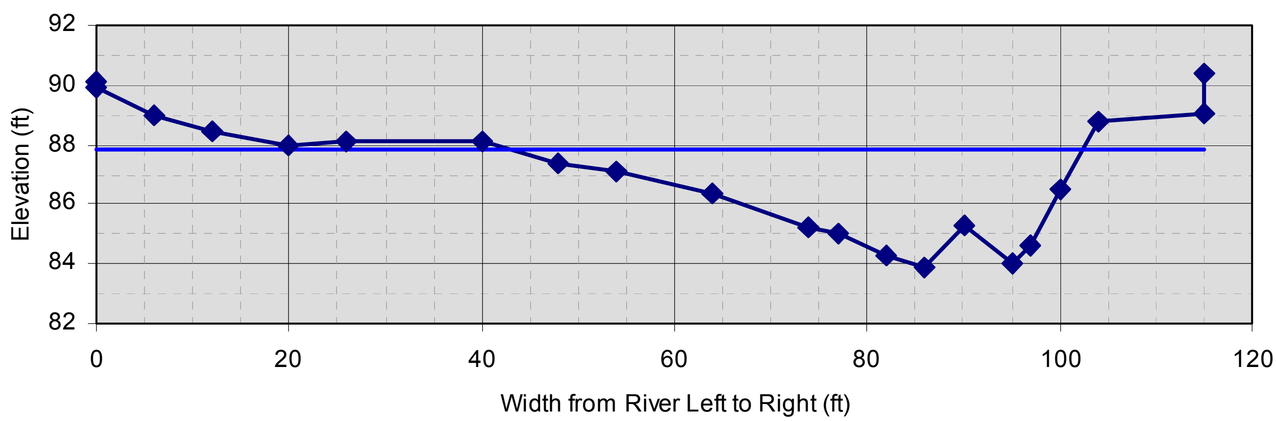
Benewah Restoration Project B_6.5 Cross Section #4 (Sta 16+90, Pool), 8/19/02.

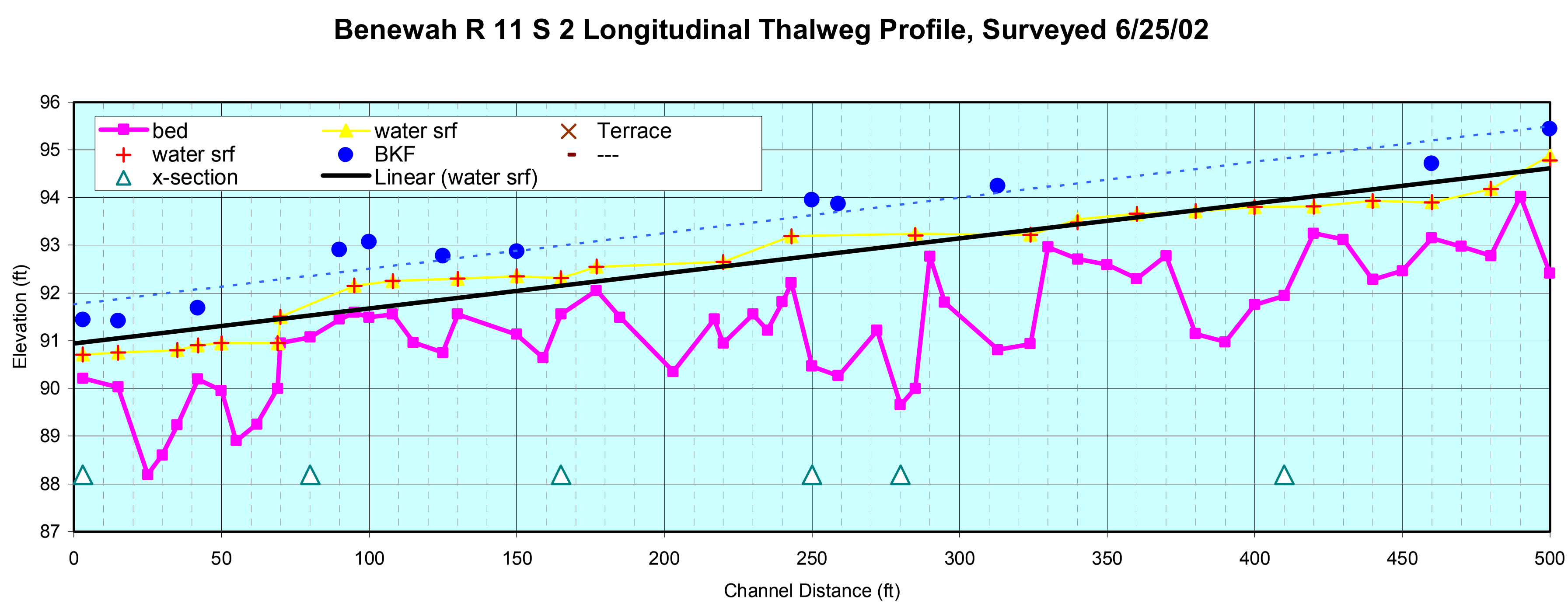


Benewah Restoration Project B_6.5 Cross Section #5 (Sta 18+23, Riffle), 8/19/02.



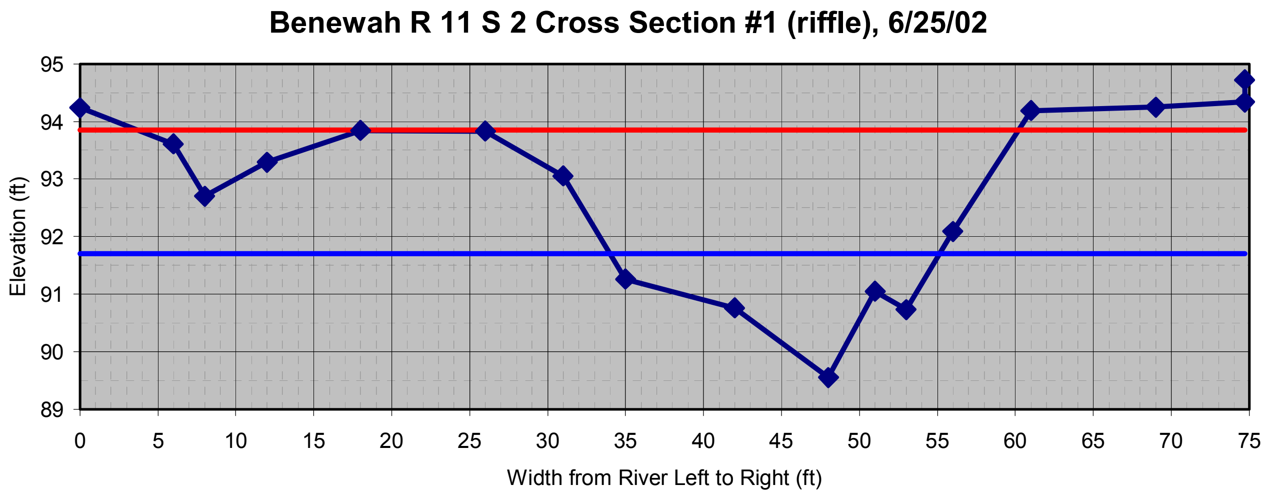
Benewah Restoration Project B_6.5 Cross Section #6 (Sta 21+15, Pool), 8/19/02.

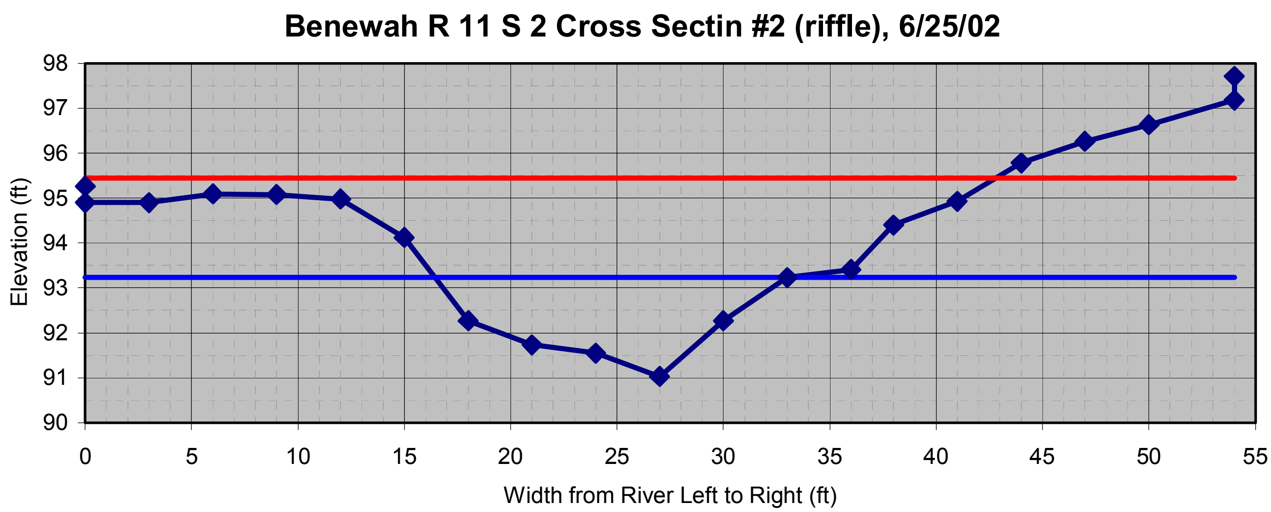


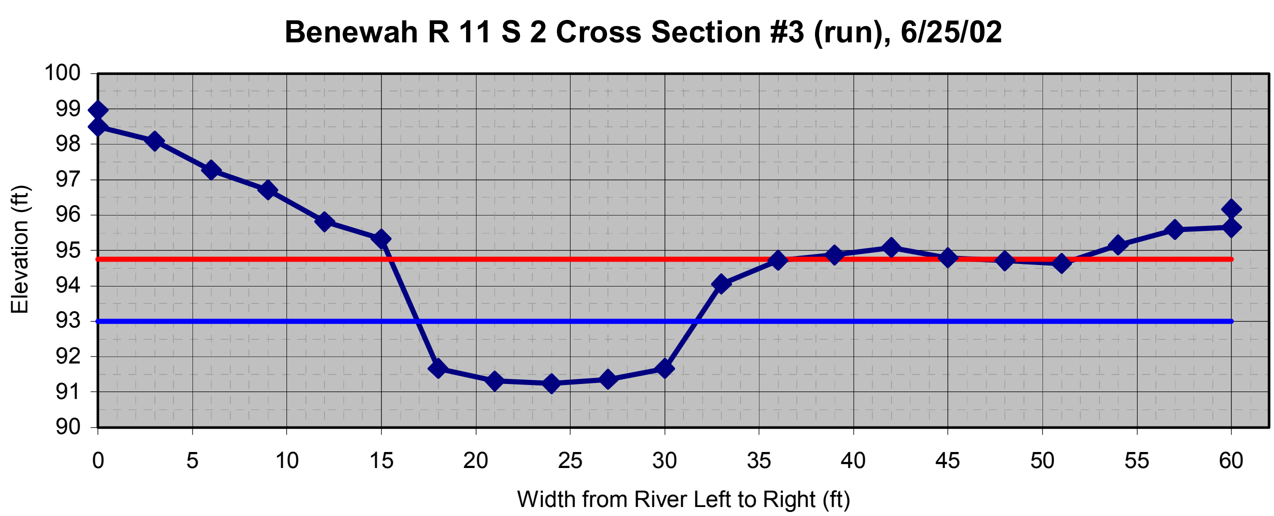


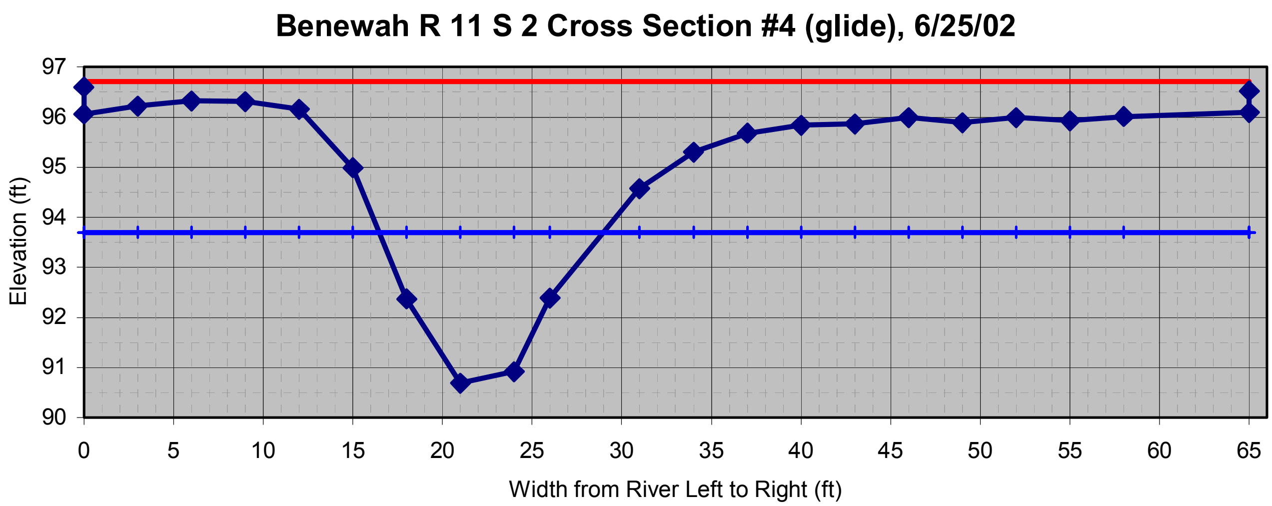
Benewah R 11 S 2 Longitudinal Thalweg Profile, Surveyed 6/25/02
bed
water srf
x-section
water srf
BKF
Linear (water srf)
Terrace

Elevation (ft)
96
95
94
93
92
91
90
89
88
87
0
50
100
150
200
250
300
350
400
450
500
Channel Distance (ft)

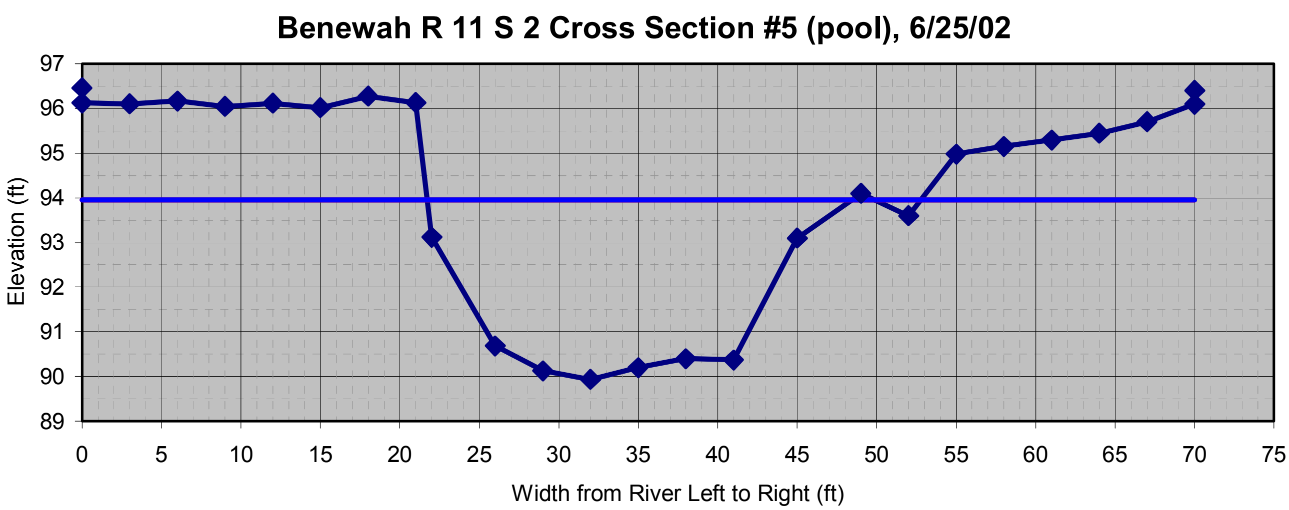

Benewah R 11 S 2 Cross Section #1 (riffle), 6/25/02
Elevation (ft)
Width from River Left to Right (ft)


Benewah R 11 S 2 Cross Sectin #2 (riffle), 6/25/02
Elevation (ft)
Width from River Left to Right (ft)

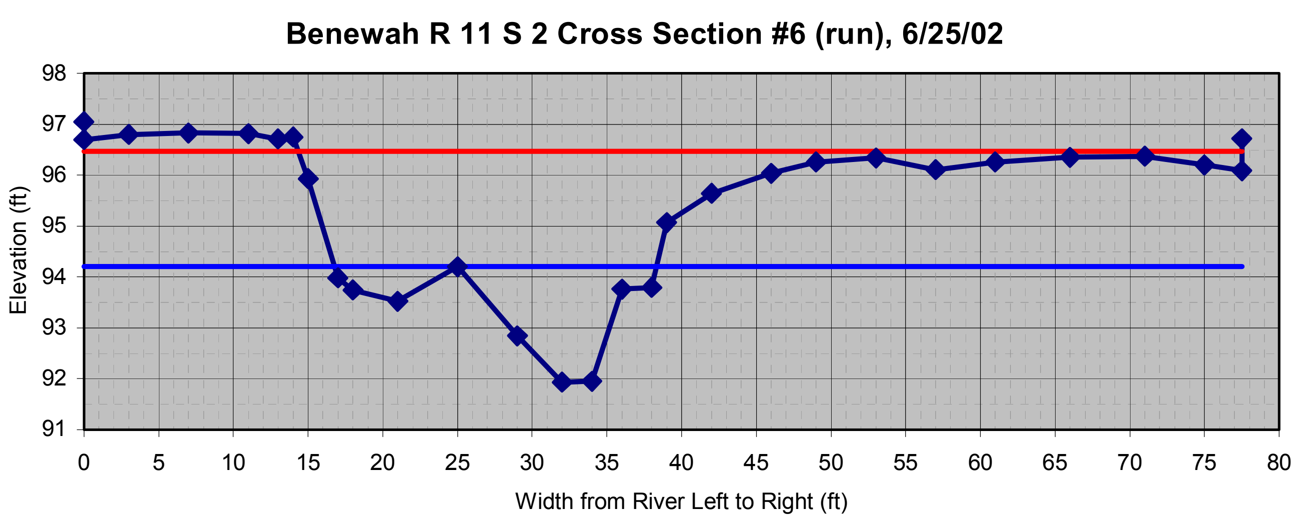

Benewah R 11 S 2 Cross Section #3 (run), 6/25/02
Elevation (ft)
Width from River Left to Right (ft)



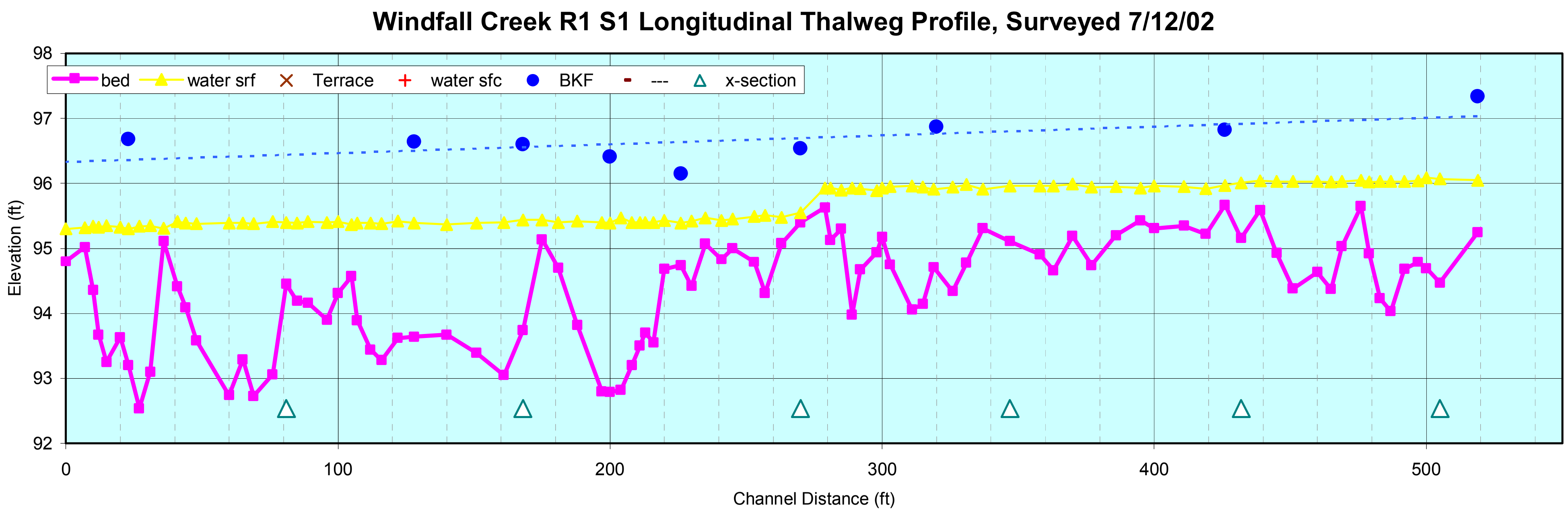
Benewah R 11 S 2 Cross Section #4 (glide), 6/25/02
Elevation (ft)
97
96
95
94
93
92
91
90
0
5
10
15
20
25
30
35
40
45
50
55
60
65
Width from River Left to Right (ft)



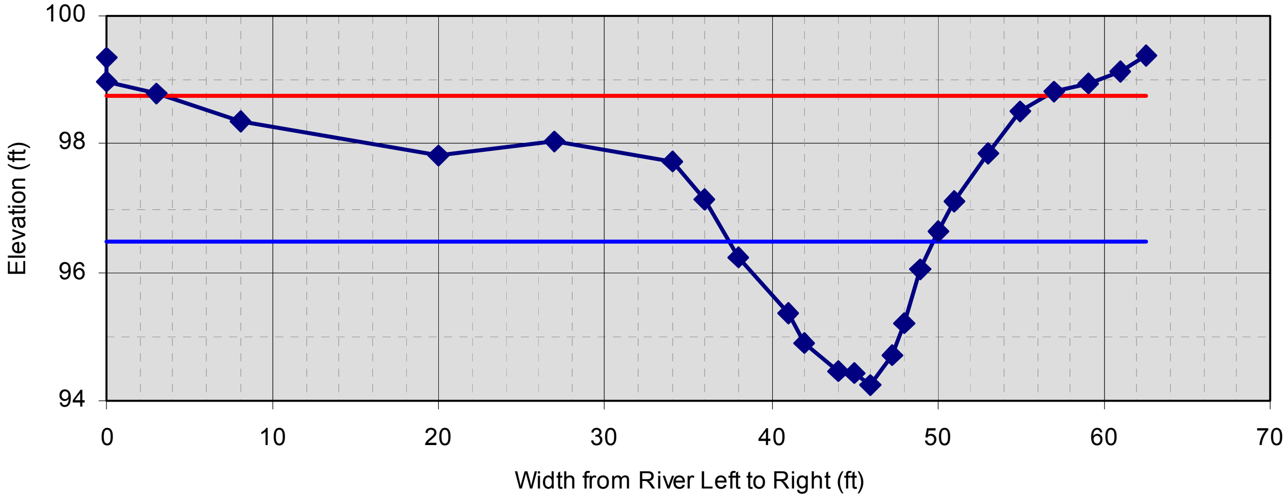
Benewah R 11 S 2 Cross Section #5 (pool), 6/25/02
Elevation (ft)
97
96
95
94
93
92
91
90
89
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
Width from River Left to Right (ft)



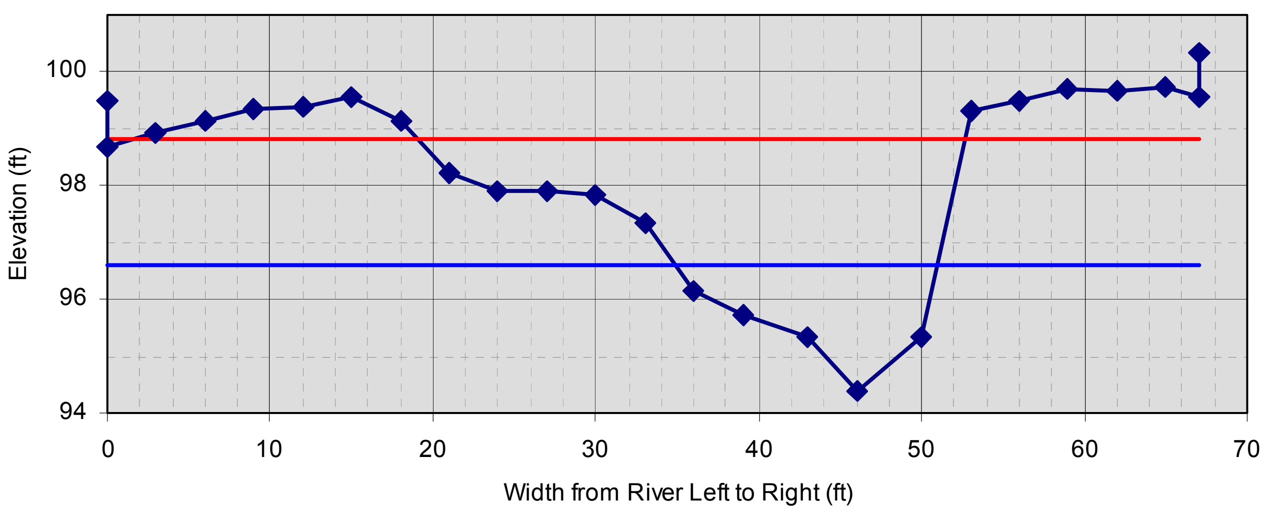
Benewah R 11 S 2 Cross Section #6 (run), 6/25/02
Elevation (ft)
98
97
96
95
94
93
92
91
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
Width from River Left to Right (ft)


Windfall Creek R1 S1 Longitudinal Thalweg Profile, Surveyed 7/12/02
bed
water srf
Terrace
water sfc
BKF
---
x-section
Elevation (ft)
98
97
96
95
94
93
92
0
100
200
300
400
500
Channel Distance (ft)

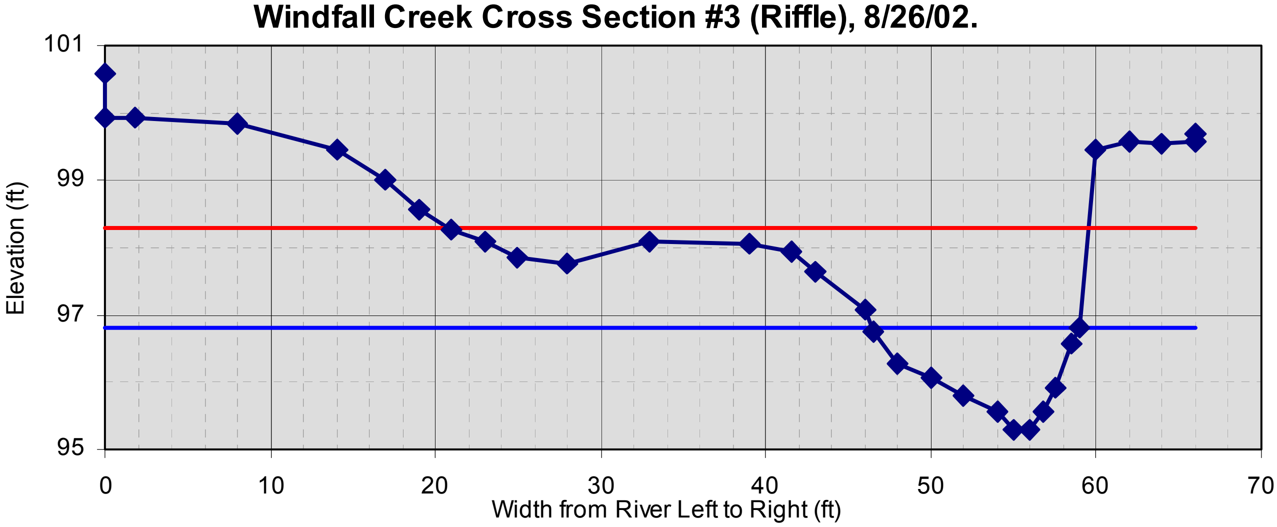
Windfall Creek Cross Section #1 (Run), 7/12/02.



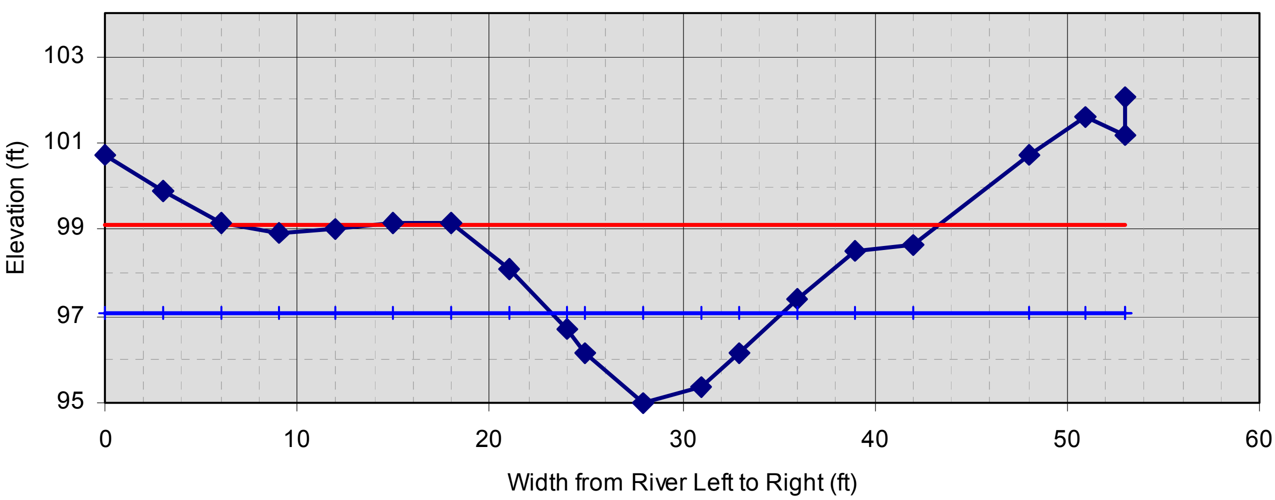
Windfall Creek Cross Section #2 (Run), 7/12/02.



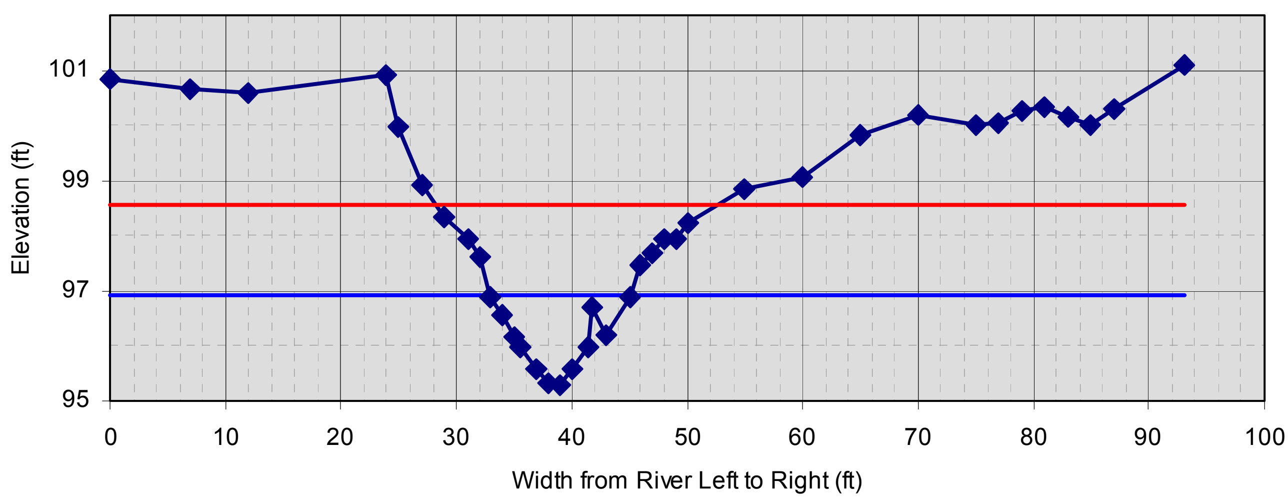
Windfall Creek Cross Section #3 (Riffle), 8/26/02.



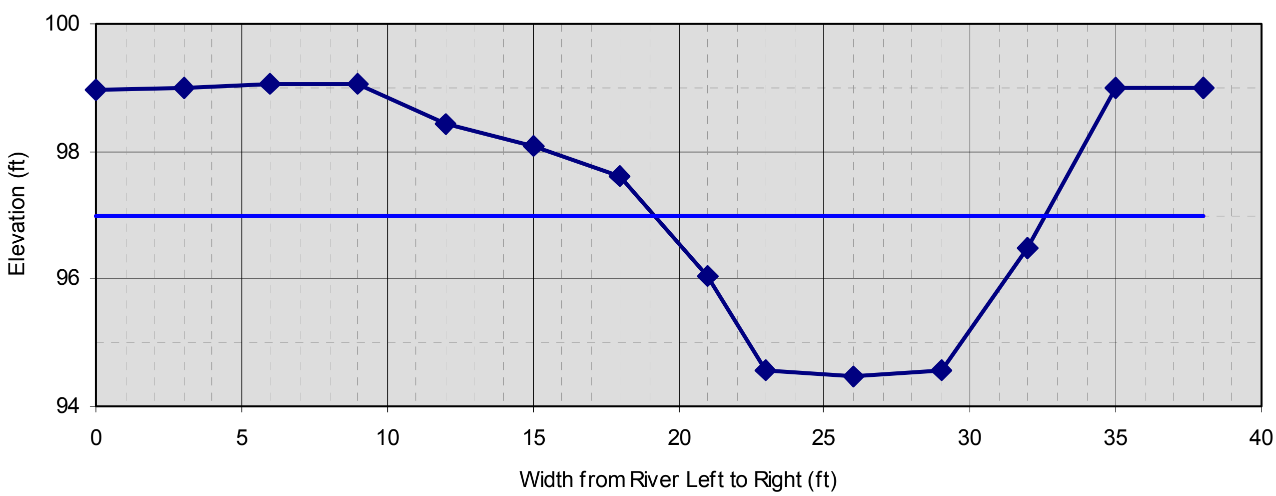
Windfall Creek Cross Section #4 (Glide), 8/26/02.



Windfall Creek Cross Section #5 (Riffle), 8/26/02.



Windfall Creek Cross Section #6 (Pool), 8/26/02.



Monitoring site -->			Benewah Evans			Benewah R 1 S 1			Benewah R 2 S 1		
			Riffle	Pool	Run	Riffle	Pool	Run	Riffle	Pool	Run
Material	Size Range (mm)		Count	Count	Count	Count	Count	Count	Count	Count	Count
silt/clay	0	0.062					20	6		20	6
very fine sand	0.062	0.13				1					
fine sand	0.13	0.25									
medium sand	0.25	0.5									
coarse sand	0.5	1									
very coarse sand	1	2					1			1	
very fine gravel	2	4									
fine gravel	4	6									
fine gravel	6	8									
medium gravel	8	11									
medium gravel	11	16	2				2			2	
coarse gravel	16	22		2							
coarse gravel	22	32	10	27		1	3	2	2	3	2
very coarse gravel	32	45	8	32	2	2	4	1	6	4	1
very coarse gravel	45	64	32	25	5	2	7	6	3	7	6
small cobble	64	90	64	29	1	5	5	6	4	5	6
medium cobble	90	128	58	32	2	6	10	6	10	10	6
large cobble	128	180	12	13	2	2	1	7	5	1	7
very large cobble	180	256	12	14		1	5	3	13	5	3
small boulder	256	362							12		
small boulder	362	512							2		
medium boulder	512	1024							3		
large boulder	1024	2048									
very large boulder	2048	4096									
bedrock											
Total Particle Count:			198	174	12	20	58	37	60	58	37

Monitoring site -->			Benewah R 2 S 2			Benewah R 3 S 1			Benewah R 3 S 2		
			Riffle	Pool	Run	Riffle	Pool	Run	Riffle	Pool	Run
Material	Size Range (mm)		Count	Count	Count	Count	Count	Count	Count	Count	Count
silt/clay	0	0.062									
very fine sand	0.062	0.13									
fine sand	0.13	0.25									
medium sand	0.25	0.5									
coarse sand	0.5	1									
very coarse sand	1	2									
very fine gravel	2	4									
fine gravel	4	6									
fine gravel	6	8									
medium gravel	8	11	2		3						
medium gravel	11	16			4						
coarse gravel	16	22	2								
coarse gravel	22	32	1		2			1			3
very coarse gravel	32	45			3	7			2		
very coarse gravel	45	64	1	1	2	1		6	7	4	7
small cobble	64	90	2		3	8		5	13	4	7
medium cobble	90	128	5	4	3	6		4	10	3	5
large cobble	128	180	6	1	4	17		3	15	5	4
very large cobble	180	256	5	3	4	9		4	8	1	1
small boulder	256	362	5	5	3	14		7	2	3	7
small boulder	362	512	1	3	1	5		2	2		1
medium boulder	512	1024	1	3		5		1	2		4
large boulder	1024	2048		2							
very large boulder	2048	4096									
bedrock			10	17	8	10		5			
Total Particle Count:			41	39	40	82	0	38	61	20	39

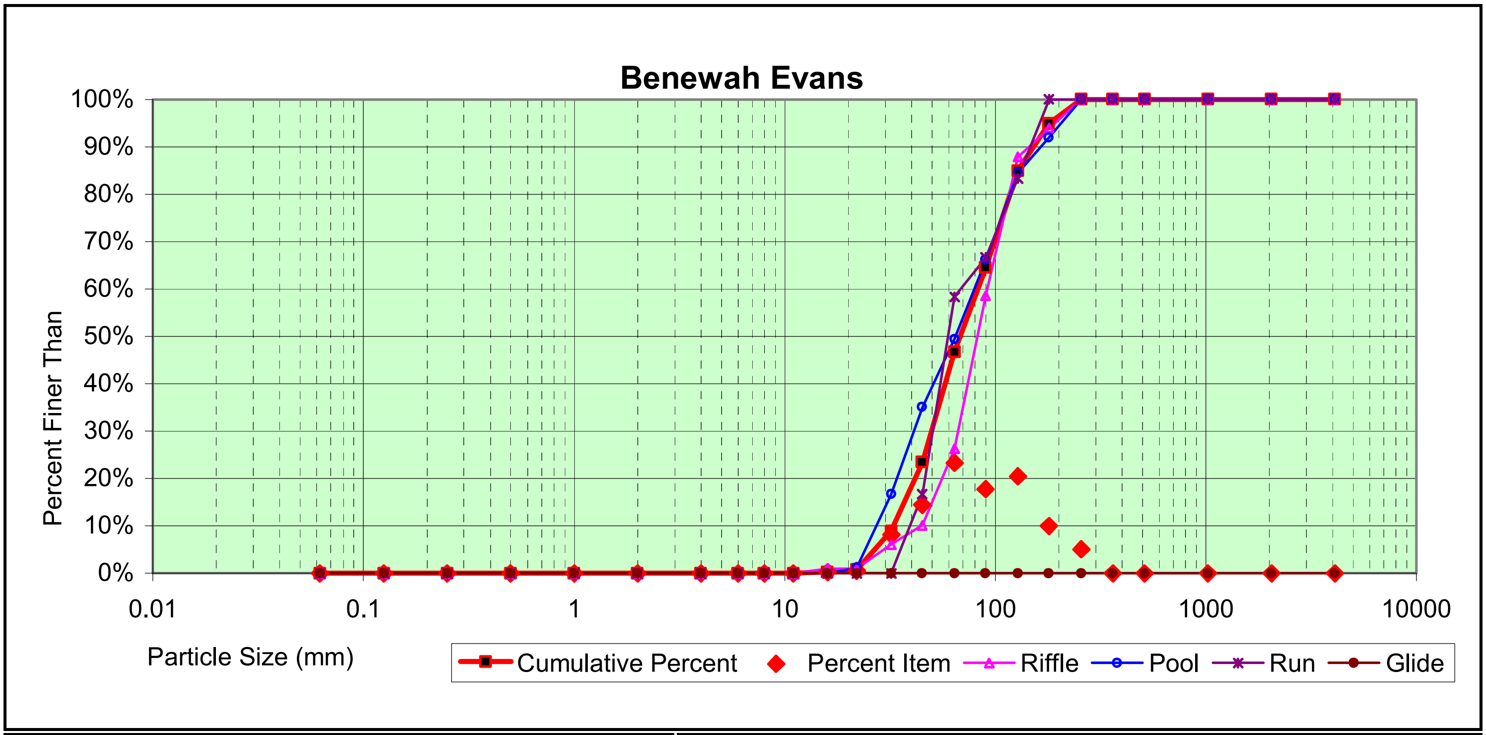
Monitoring site -->			Benewah R 4 S 1			Benewah R 4 S 2			Benewah R 8 S 1		
			Riffle	Pool	Run	Riffle	Pool	Run	Riffle	Pool	Run
Material	Size Range (mm)		Count	Count	Count	Count	Count	Count	Count	Count	Count
silt/clay	0	0.062									
very fine sand	0.062	0.13					2				
fine sand	0.13	0.25									
medium sand	0.25	0.5									
coarse sand	0.5	1									
very coarse sand	1	2									
very fine gravel	2	4									
fine gravel	4	6									
fine gravel	6	8									
medium gravel	8	11					1				
medium gravel	11	16					1	1			
coarse gravel	16	22	2				3	1	1		
coarse gravel	22	32	3			4	2		2		
very coarse gravel	32	45	3		3	2	3	1	3		3
very coarse gravel	45	64	6		1	8		1	3		6
small cobble	64	90	6		1	5		1	6		6
medium cobble	90	128	10		4	6		4	6	3	4
large cobble	128	180	10		5	15	1	2	7	5	5
very large cobble	180	256	15		10	4		1	5	4	7
small boulder	256	362	12		4	5	1	2	5	6	3
small boulder	362	512	2		6	1	1	1	4	2	4
medium boulder	512	1024	7		7	3		2	3		2
large boulder	1024	2048			1	1			3		1
very large boulder	2048	4096									
bedrock						25	6	3	11		
Total Particle Count:			76	0	42	79	21	20	59	20	41

Monitoring site -->			Benewah R 8 S 2			Benewah R 9 S 1			Benewah R 9 S 2		
			Riffle	Pool	Run	Riffle	Pool	Run	Riffle	Pool	Run
Material	Size Range (mm)		Count	Count	Count	Count	Count	Count	Count	Count	Count
silt/clay	0	0.062					5				
very fine sand	0.062	0.13									
fine sand	0.13	0.25									
medium sand	0.25	0.5									
coarse sand	0.5	1									
very coarse sand	1	2									
very fine gravel	2	4									
fine gravel	4	6									
fine gravel	6	8									
medium gravel	8	11									
medium gravel	11	16								3	
coarse gravel	16	22			2			1			5
coarse gravel	22	32	2		4			2		6	8
very coarse gravel	32	45	2		12		5	5	1	6	10
very coarse gravel	45	64	4		2	6	7	9	3	2	10
small cobble	64	90	3	4	13	4	3	11	4	1	12
medium cobble	90	128	12	5	10	7	2	15	2	2	8
large cobble	128	180	11	8	12	3		4			10
very large cobble	180	256	1	2	2	6			4		15
small boulder	256	362	3		1	5			3		1
small boulder	362	512	1			1		1	1		1
medium boulder	512	1024	2	1		1			1	1	
large boulder	1024	2048	1								
very large boulder	2048	4096									
bedrock											
	Total Particle Count:		42	20	58	33	22	48	19	21	80

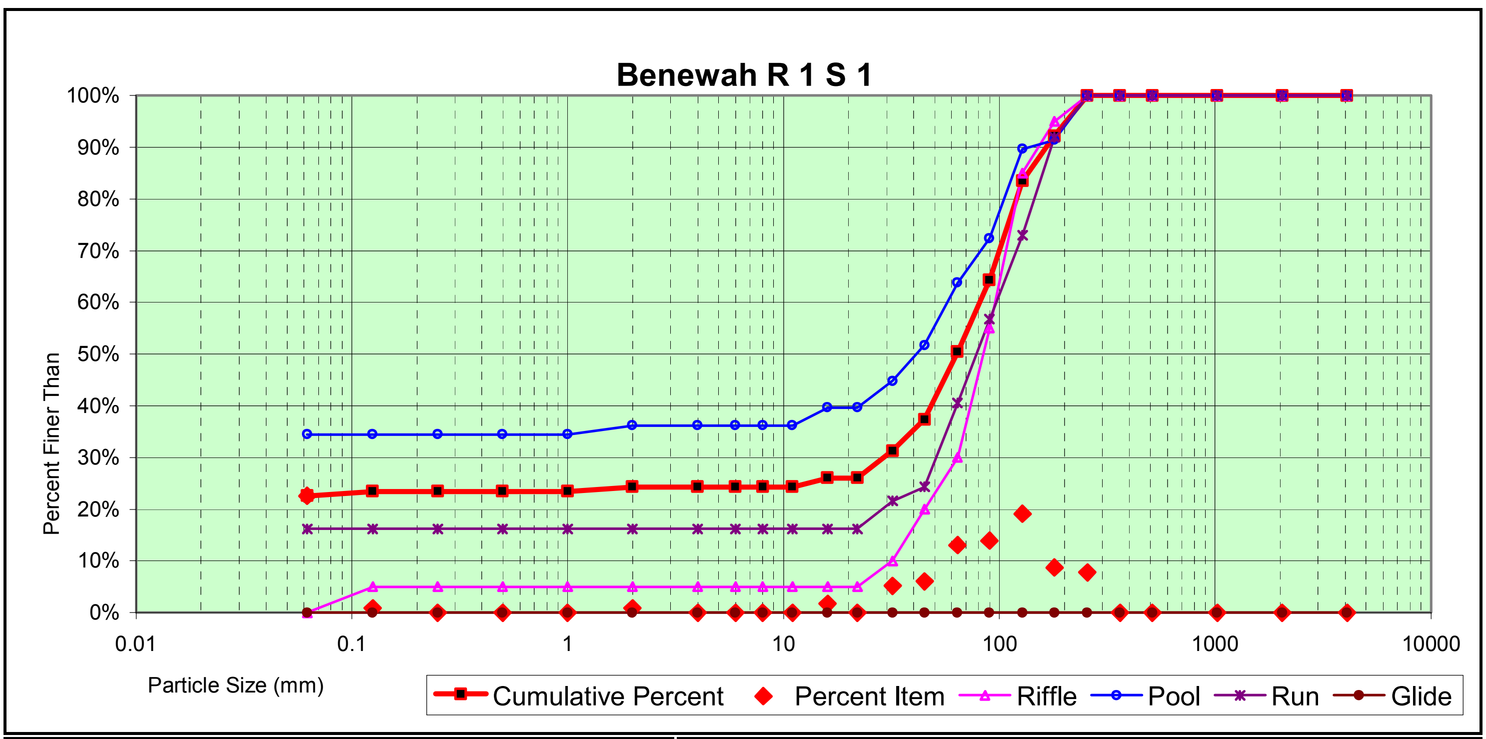
Monitoring site -->			Benewah R 10 S 1			Benewah R 10 S 2			Benewah R 10 S 3		
			Riffle	Pool	Run	Riffle	Pool	Run	Riffle	Pool	Run
Material	Size Range (mm)		Count	Count	Count	Count	Count	Count	Count	Count	Count
silt/clay	0	0.062				5	20				
very fine sand	0.062	0.13									
fine sand	0.13	0.25									
medium sand	0.25	0.5									
coarse sand	0.5	1									
very coarse sand	1	2									
very fine gravel	2	4									
fine gravel	4	6									
fine gravel	6	8									
medium gravel	8	11		1	1				4	1	1
medium gravel	11	16		1					5		
coarse gravel	16	22		2			5	1	5		5
coarse gravel	22	32	1	6		2	6	1	4	3	4
very coarse gravel	32	45	1	9	1		7	7	3	3	5
very coarse gravel	45	64	3	9	2	2	11	4	2	7	4
small cobble	64	90	6	6	6	13	5	5	6	10	5
medium cobble	90	128	1	6	13	9	5	1	4	10	3
large cobble	128	180	5	2	8	3	2		5	3	4
very large cobble	180	256	2	2	5	6			5	5	4
small boulder	256	362	1	1	3						
small boulder	362	512									
medium boulder	512	1024			1						
large boulder	1024	2048									
very large boulder	2048	4096									
bedrock											
	Total Particle Count:		20	45	40	40	61	19	43	42	35

Monitoring site -->			Benewah R 11 S 1			Benewah R 11 S 2			Coon R 5 S 1		
			Riffle	Pool	Run	Riffle	Pool	Run	Riffle	Pool	Run
Material	Size Range (mm)		Count	Count	Count	Count	Count	Count	Count	Count	Count
silt/clay	0	0.062		15		1	23	2			
very fine sand	0.062	0.13				4	15	1			
fine sand	0.13	0.25					2				
medium sand	0.25	0.5				4	7				
coarse sand	0.5	1				3	4	1			
very coarse sand	1	2				2	1				
very fine gravel	2	4		2		2	1				
fine gravel	4	6		3		1	0				
fine gravel	6	8		2		3	5	1			
medium gravel	8	11	1	7	1	6	6	4			
medium gravel	11	16	4	14	4	8	14	3			
coarse gravel	16	22	9	14	9	7	12	4			
coarse gravel	22	32	22	5	22	10	16	2			
very coarse gravel	32	45	26	8	26	3	10	9			
very coarse gravel	45	64	17	6	13	8	8	1			
small cobble	64	90	7	3	7	14	2	6			
medium cobble	90	128	2	1	2	9	2	6	4		5
large cobble	128	180				1			5		6
very large cobble	180	256				1			12		11
small boulder	256	362							6		5
small boulder	362	512						1	6		4
medium boulder	512	1024							17		3
large boulder	1024	2048							13		8
very large boulder	2048	4096									
bedrock									10		5
	Total Particle Count:		88	80	84	87	128	41	73	0	47

Monitoring site -->		Whitetail R 1 S 2			Windfall R 1 S 1			Windfall R 1 S 2		
		Riffle	Pool	Run	Riffle	Pool	Run	Riffle	Pool	Run
Material	Size Range (mm)	Count	Count	Count	Count	Count	Count	Count	Count	Count
silt/clay	0 0.062	20	5	20		17	20	15	20	5
very fine sand	0.062 0.13				2	7	7			
fine sand	0.13 0.25				1					
medium sand	0.25 0.5									
coarse sand	0.5 1									
very coarse sand	1 2									
very fine gravel	2 4				1					
fine gravel	4 6				1	3	1		3	
fine gravel	6 8				10	3	2			
medium gravel	8 11	1		1	4	6	4	2	5	3
medium gravel	11 16			2	1	6	5		1	4
coarse gravel	16 22	2		1		7	2	3	4	1
coarse gravel	22 32	5	1	1		2	1	2	5	1
very coarse gravel	32 45	9	2	2		7		3	6	4
very coarse gravel	45 64	7	4	7				2	7	2
small cobble	64 90	10	2	5				7	3	
medium cobble	90 128	4	3	1				4	3	
large cobble	128 180	1	3							
very large cobble	180 256	1						2	3	
small boulder	256 362									
small boulder	362 512									
medium boulder	512 1024									
large boulder	1024 2048									
very large boulder	2048 4096									
bedrock										
	Total Particle Count:	60	20	40	20	58	42	40	60	20

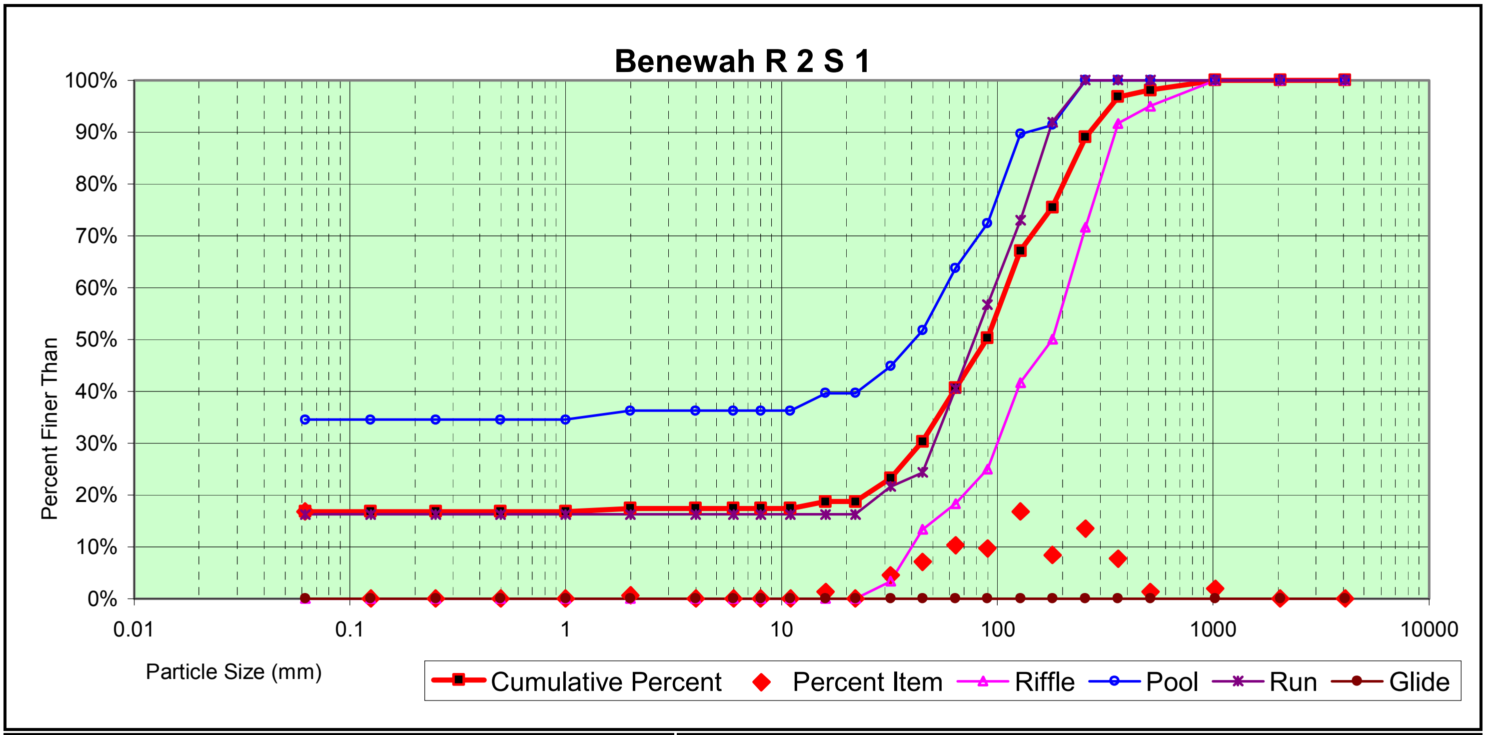


	Size percent less than (mm)				Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
37.793	53.6	68.1	126.0	180.8	0%	0%	47%	53%	0%	0%



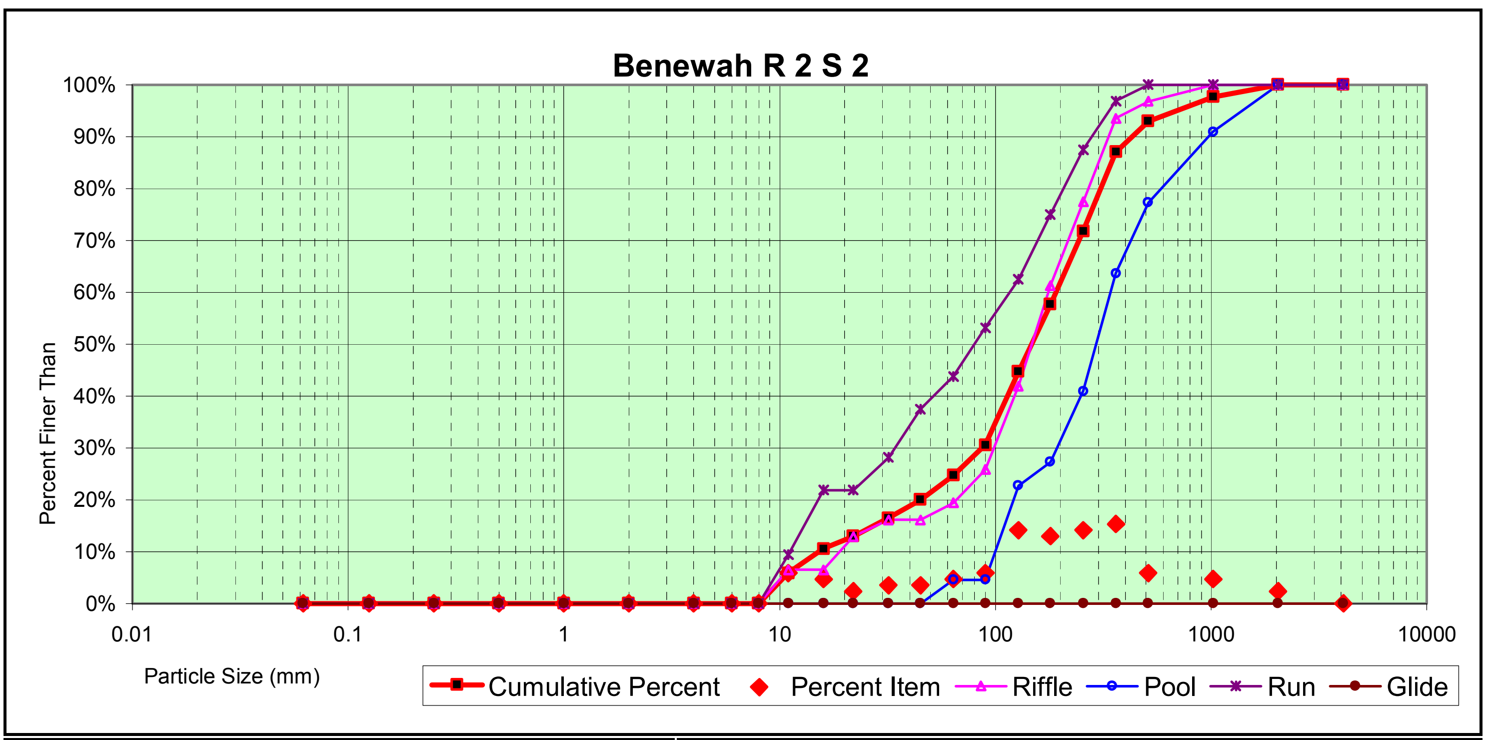
	Size percent less than (mm)				Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
#N/A	39.4	63.3	130.7	204.4	23%	2%	26%	50%	0%	0%

* NOTE: ~~Preliminary estimate of percentage of habitat types (riffle, pool, run) used for calculation of "Size percent less" based on percent of pebble counts for that type.~~



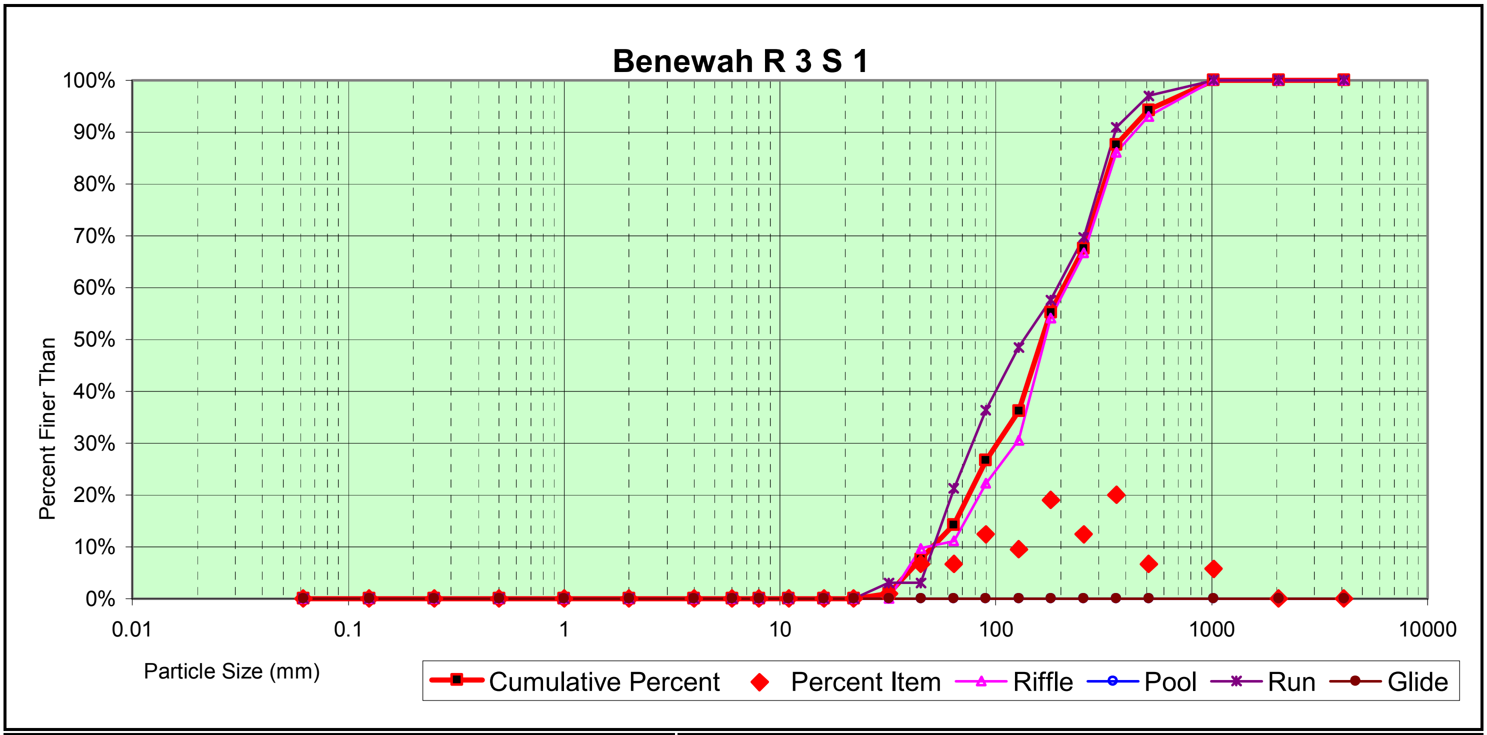
	Size percent less than (mm)					Percent by substrate type				
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
#N/A	52.8	89.0	224.6	334.4	16.77%	0.64%	23.23%	48.39%	10.97%	0.00%

* NOTE: Preliminary estimate of percentage of habitat types (riffle, pool, run) used for calculation of "Size percent less" based on percent of pebble counts for that type.



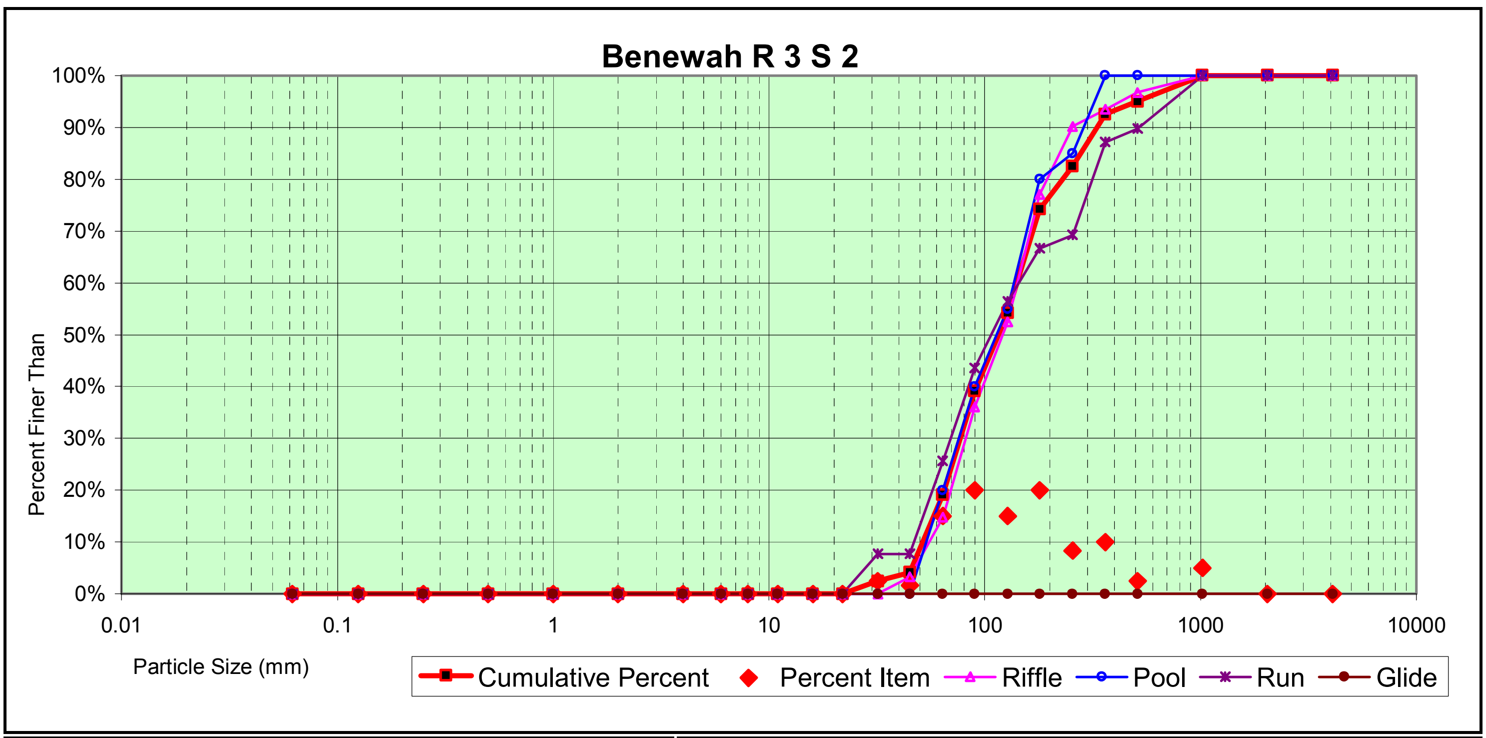
Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
30.455	100.5	147.2	337.8	693.5	0%	0%	17%	33%	20%	29%

* NOTE: Preliminary estimate of percentage of habitat types (riffle, pool, run) used for calculation of "Size percent less" based on percent of pebble counts for that type.



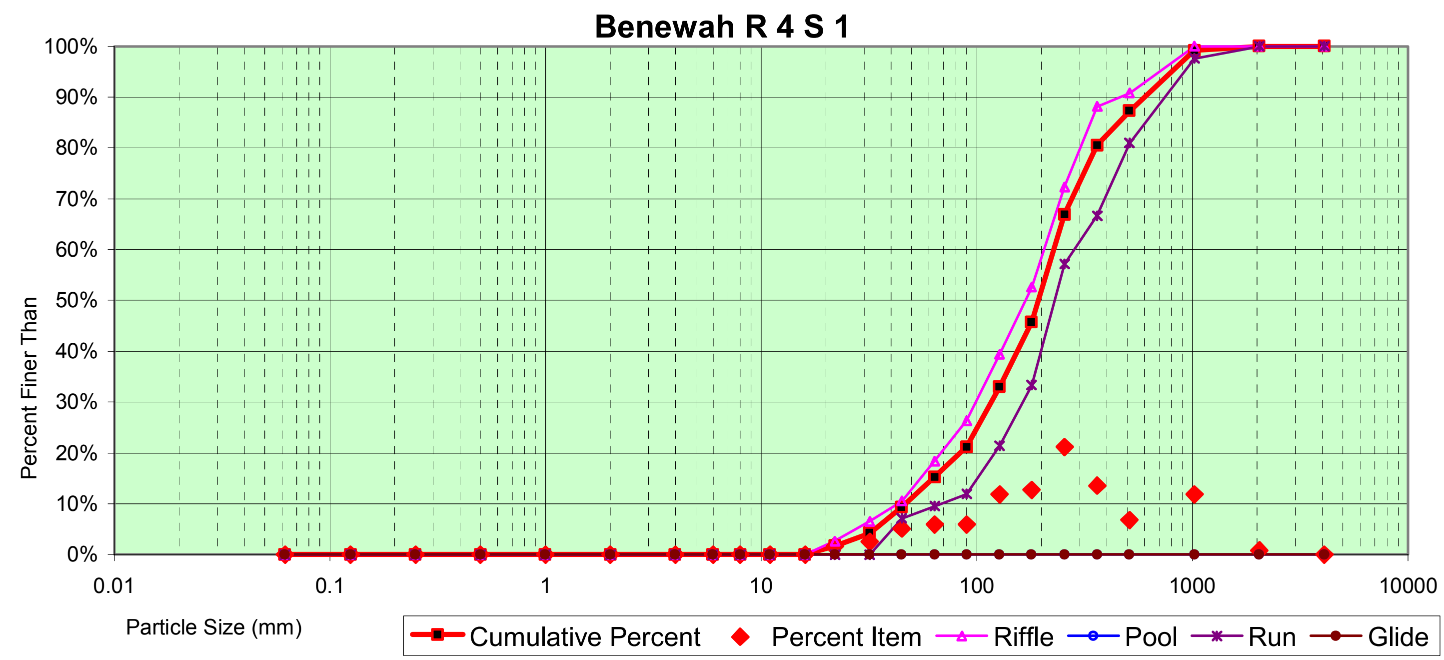
	Size percent less than (mm)					Percent by substrate type				
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
67.1	122.5	163.9	340.0	558.3	0.00%	0%	13%	47%	28%	13%

* NOTE: Preliminary estimate of percentage of habitat types (riffle, pool, run) used for calculation of "Size percent less" based on percent of pebble counts for that type.



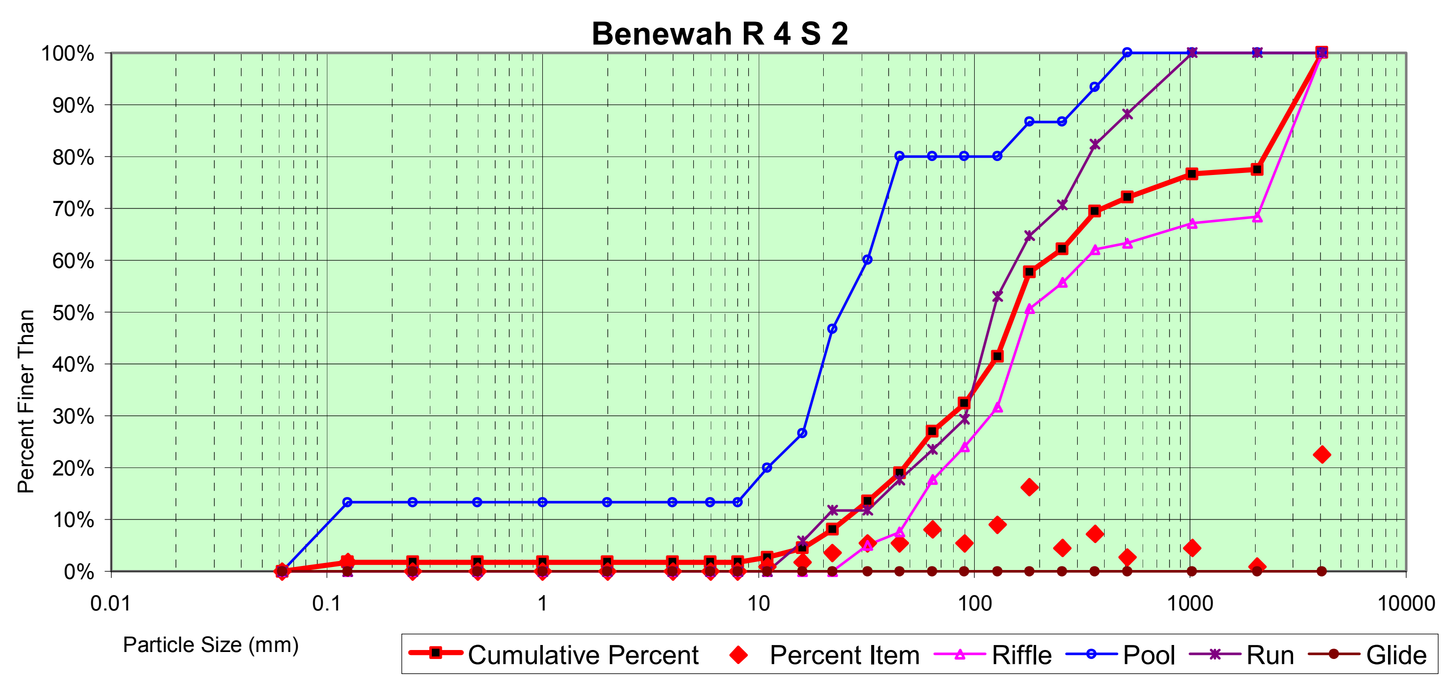
	Size percent less than (mm)					Percent by substrate type				
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
59.4	83.8	116.1	269.7	511.9	0%	0%	19%	63%	18%	0%

* NOTE: Preliminary estimate of percentage of habitat types (riffle, pool, run) used for calculation of "Size percent less" based on percent of pebble counts for that type.



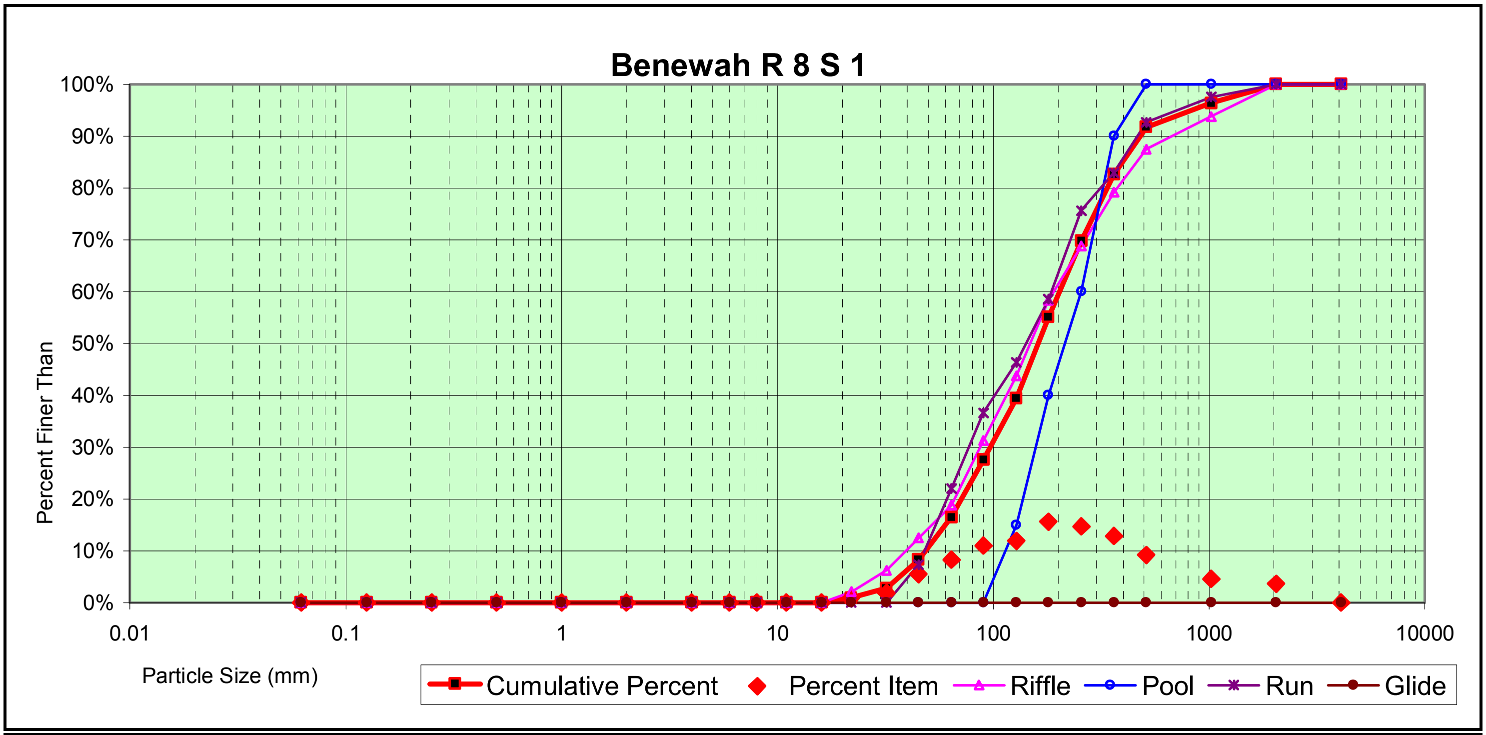
	Size percent less than (mm)					Percent by substrate type			
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
66.8	134.9	193.1	432.8	803.4	0%	0%	15%	52%	33%	0%

* NOTE: Preliminary estimate of percentage of habitat types (riffle, pool, run) used for calculation of "Size percent less" based on percent of pebble counts for that type.



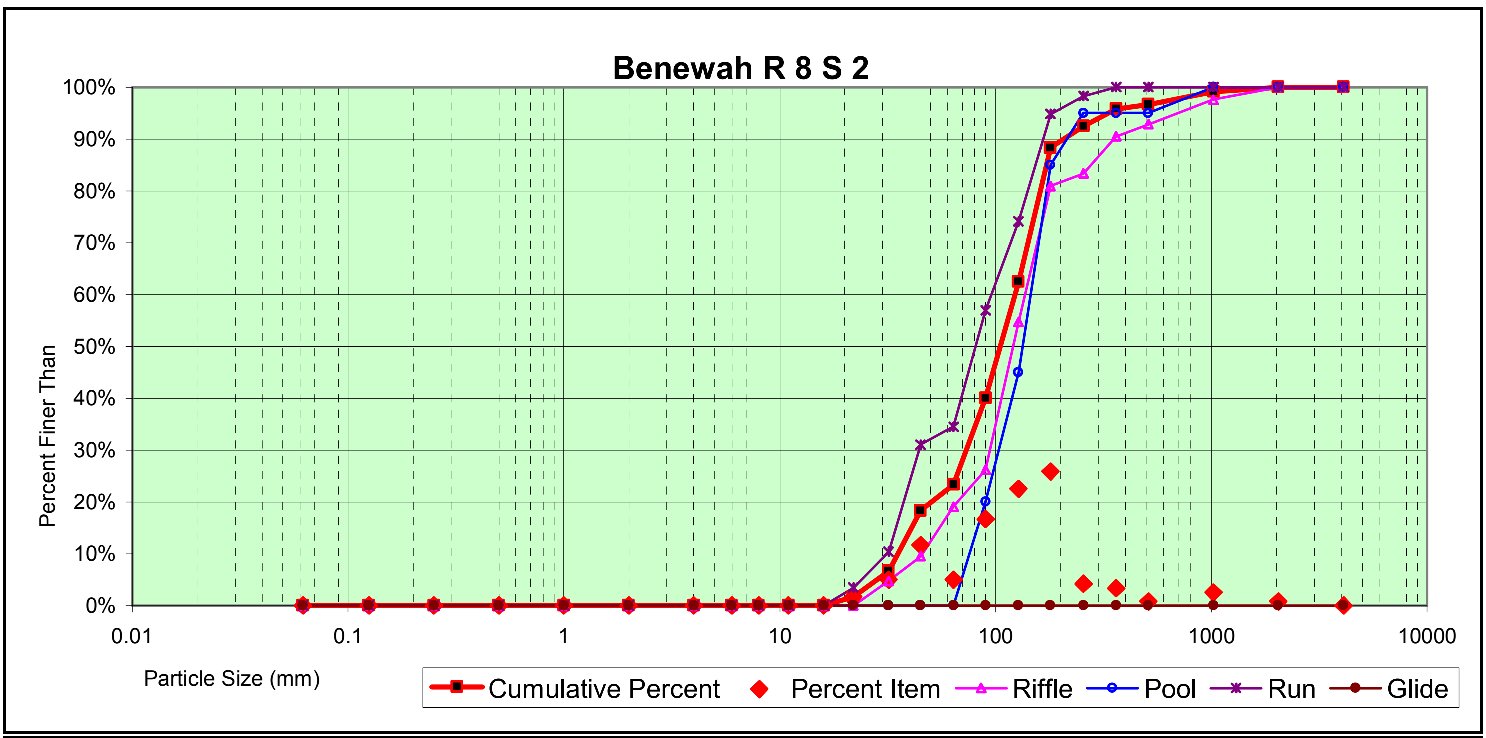
	Size percent less than (mm)					Percent by substrate type				
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
37.4	99.5	153.2	2502.7	3511.6	0%	1%	19%	27%	29%	23%

* NOTE: Preliminary estimate of percentage of habitat types (riffle, pool, run) used for calculation of "Size percent less" based on percent of pebble counts for that type.



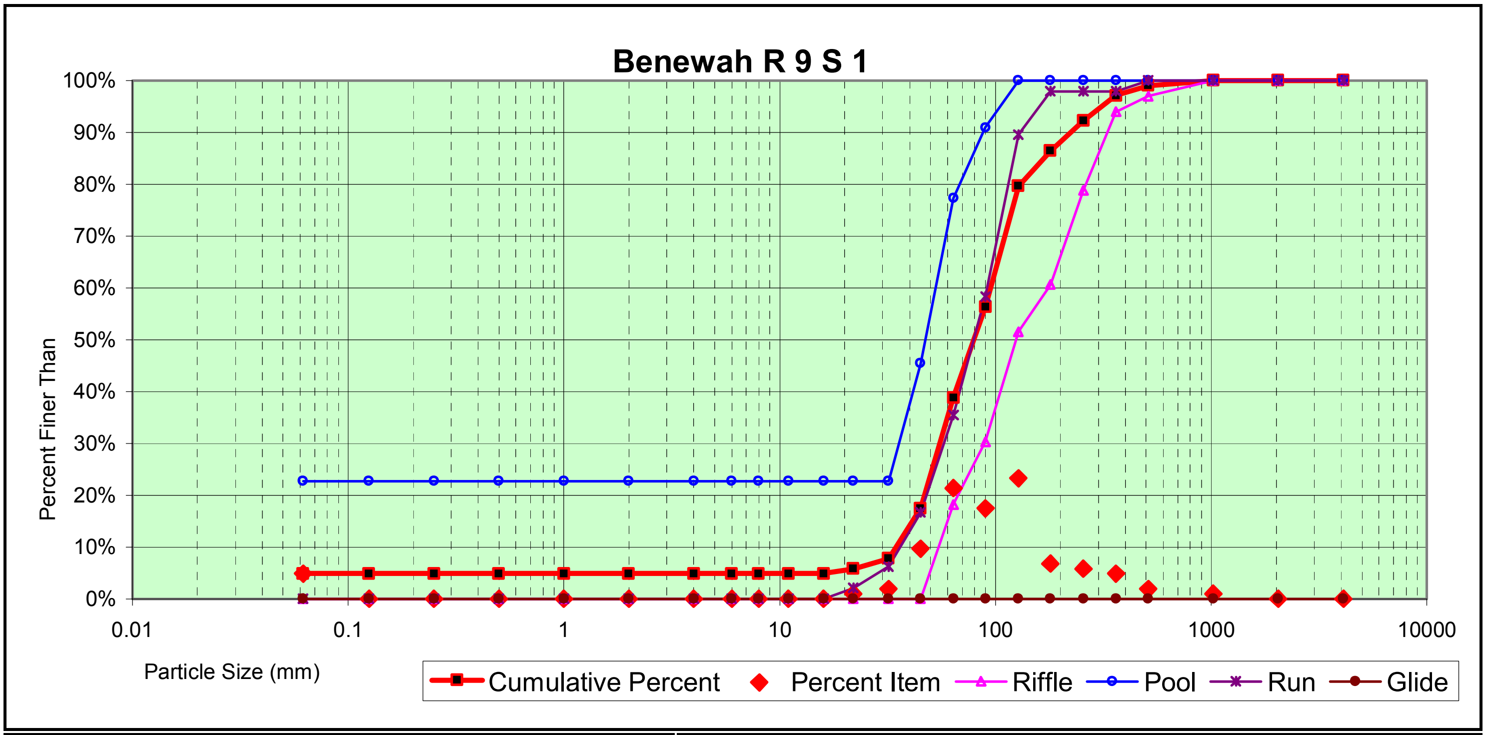
	Size percent less than (mm)					Percent by substrate type				
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
62.6	112.3	161.2	382.1	837.4	0%	0%	15%	48%	28%	9%

* NOTE: Preliminary estimate of percentage of habitat types (riffle, pool, run) used for calculation of "Size percent less" based on percent of pebble counts for that type.



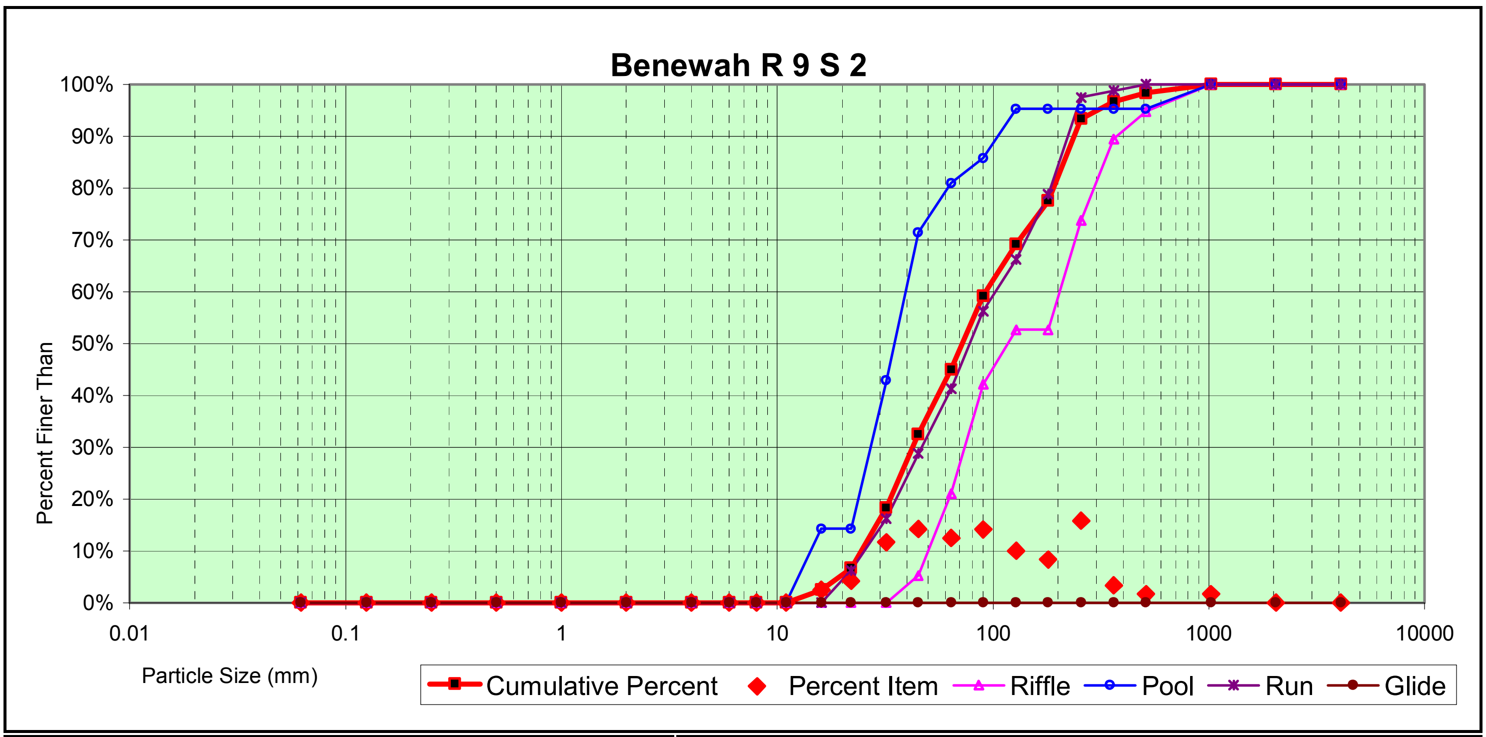
	Size percent less than (mm)					Percent by substrate type				
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
42.0	81.3	105.3	170.0	332.0	0%	0%	23%	69%	8%	0%

* NOTE: Preliminary estimate of percentage of habitat types (riffle, pool, run) used for calculation of "Size percent less" based on percent of pebble counts for that type.



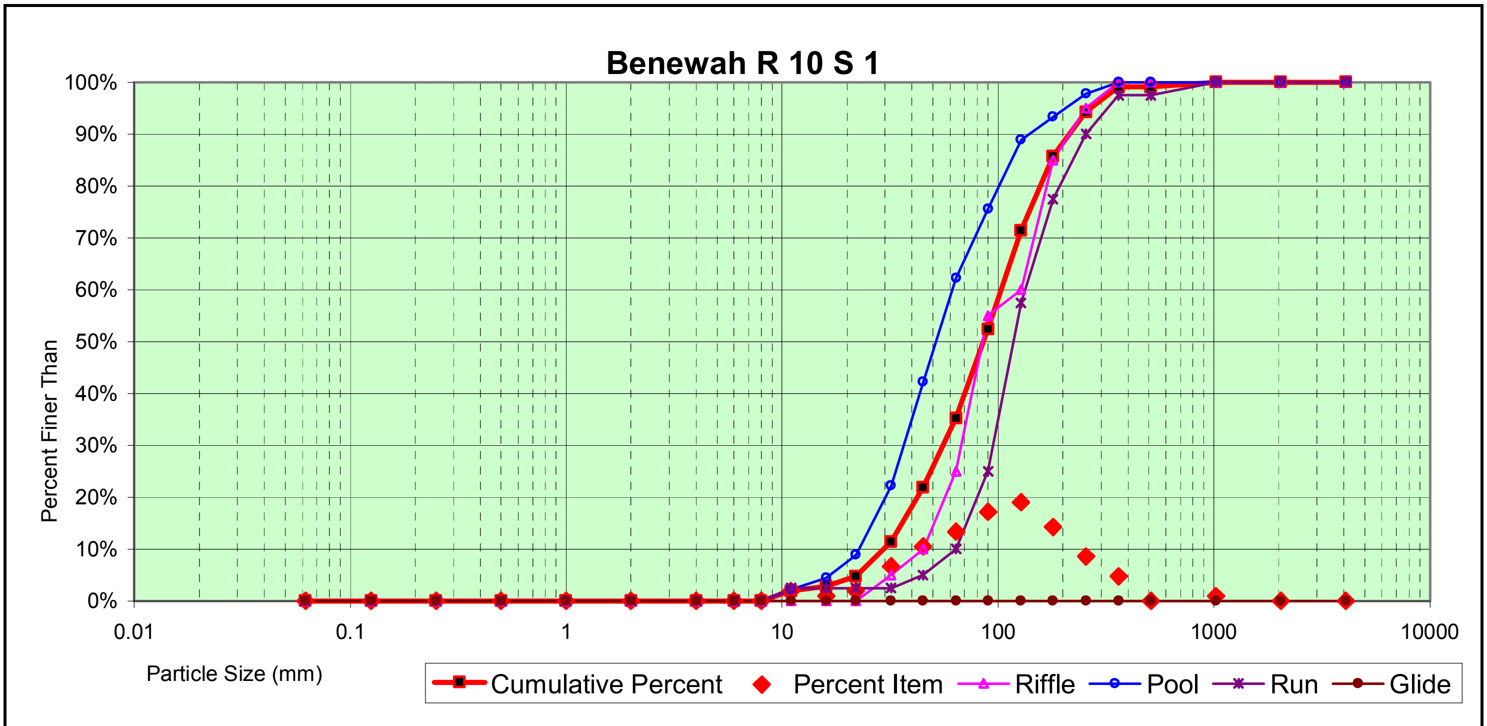
	Size percent less than (mm)				Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
42.7	60.1	79.6	159.5	311.9	4%	0%	28%	44%	6%	18%

* NOTE: Preliminary estimate of percentage of habitat types (riffle, pool, run) used for calculation of "Size percent less" based on percent of pebble counts for that type.



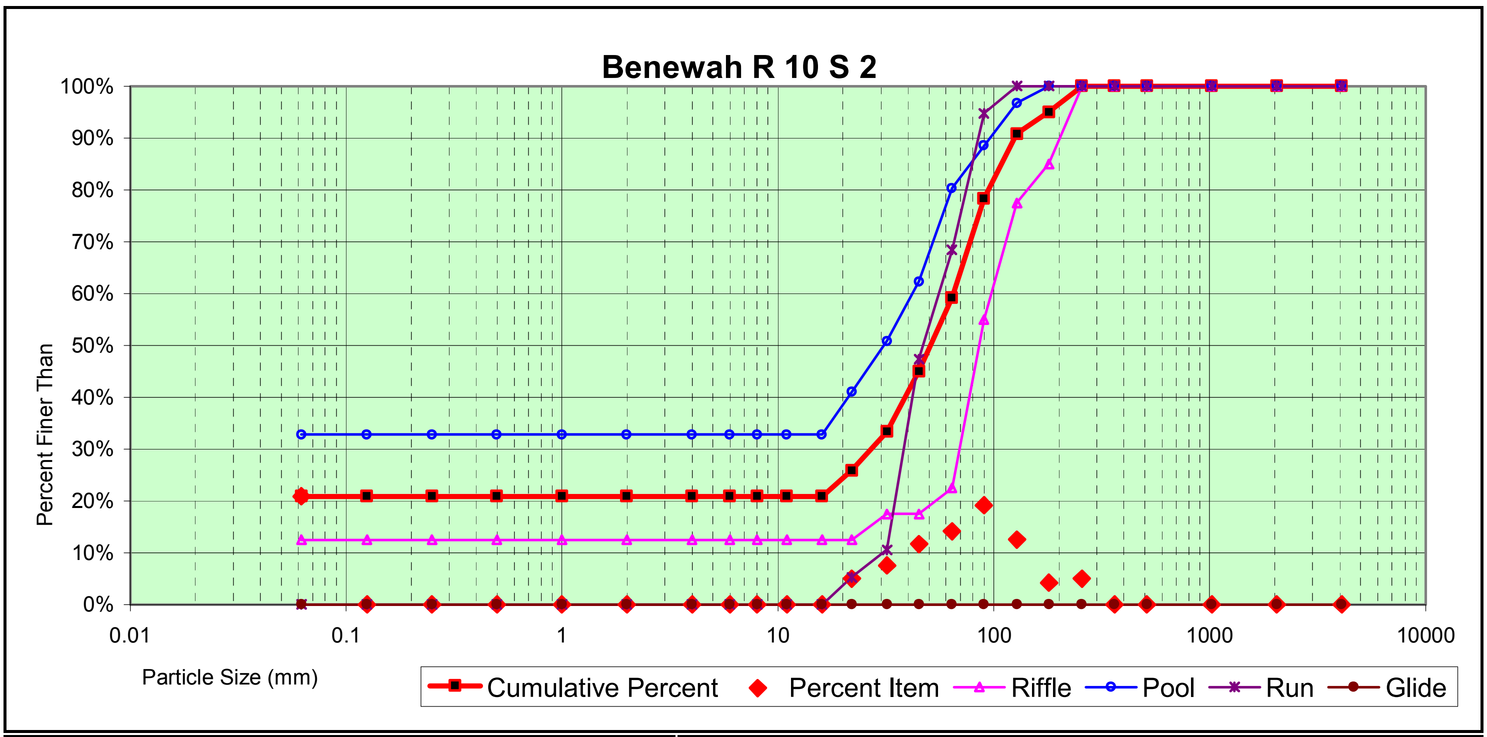
	Size percent less than (mm)				Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
29.7	48.3	72.2	208.0	304.2	0%	0%	45%	48%	7%	0%

* NOTE: Preliminary estimate of percentage of habitat types (riffle, pool, run) used for calculation of "Size percent less" based on percent of pebble counts for that type.



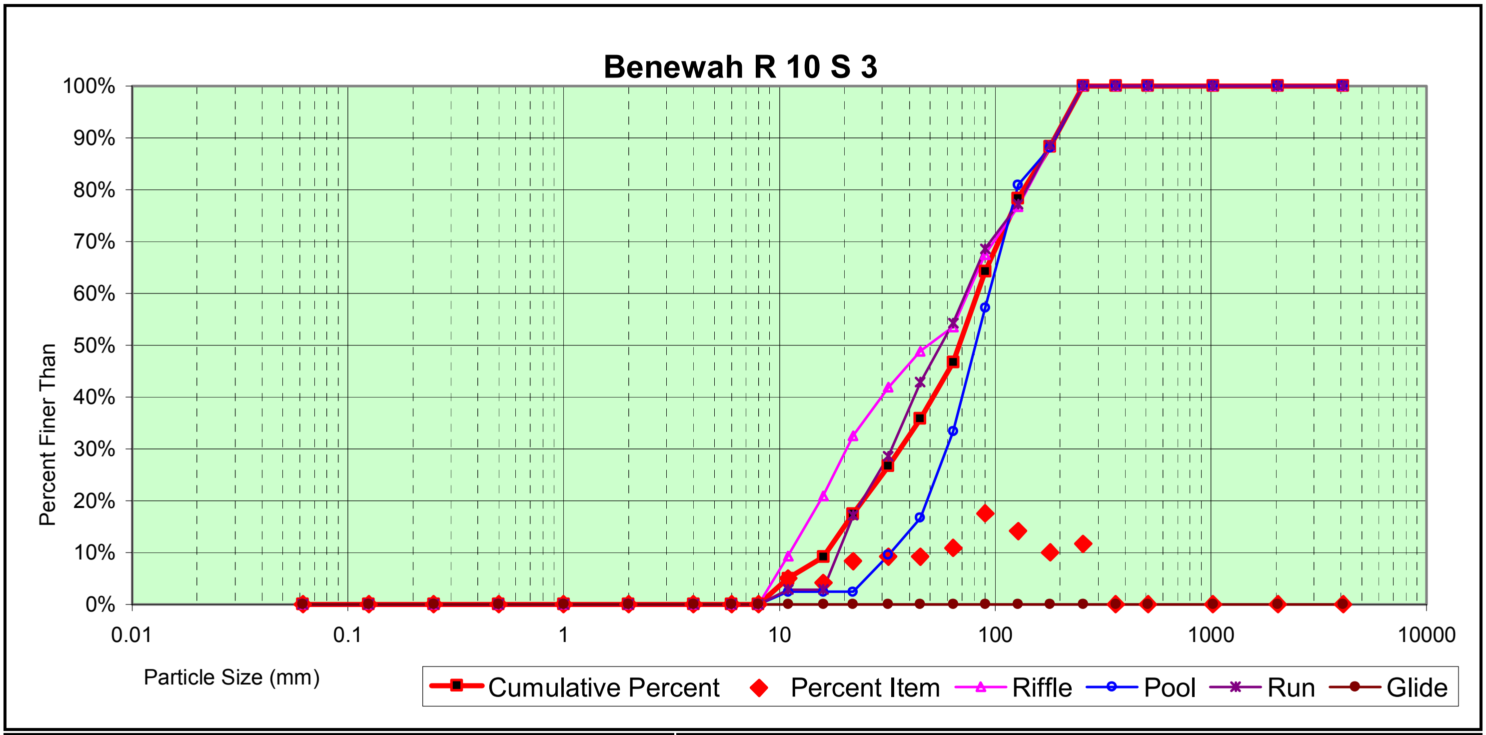
	Size percent less than (mm)				Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
37.1	63.6	85.8	172.8	269.6	0%	0%	31%	52%	5%	13%

* NOTE: Preliminary estimate of percentage of habitat types (riffle, pool, run) used for calculation of "Size percent less" based on percent of pebble counts for that type.



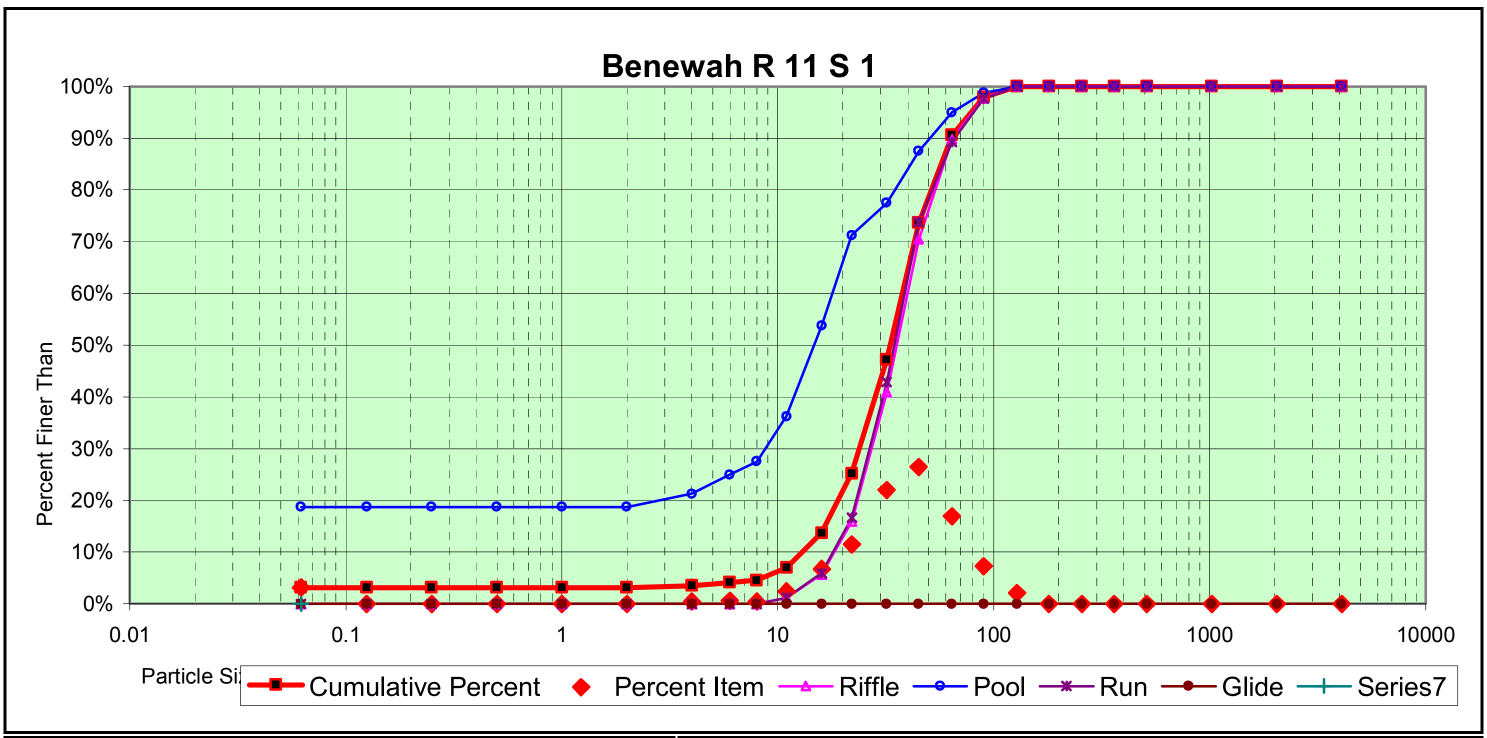
	Size percent less than (mm)				Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
#N/A	33.6	51.0	105.6	180.0	21%	0%	38%	41%	0%	0%

* NOTE: Preliminary estimate of percentage of habitat types (riffle, pool, run) used for calculation of "Size percent less" based on percent of pebble counts for that type.

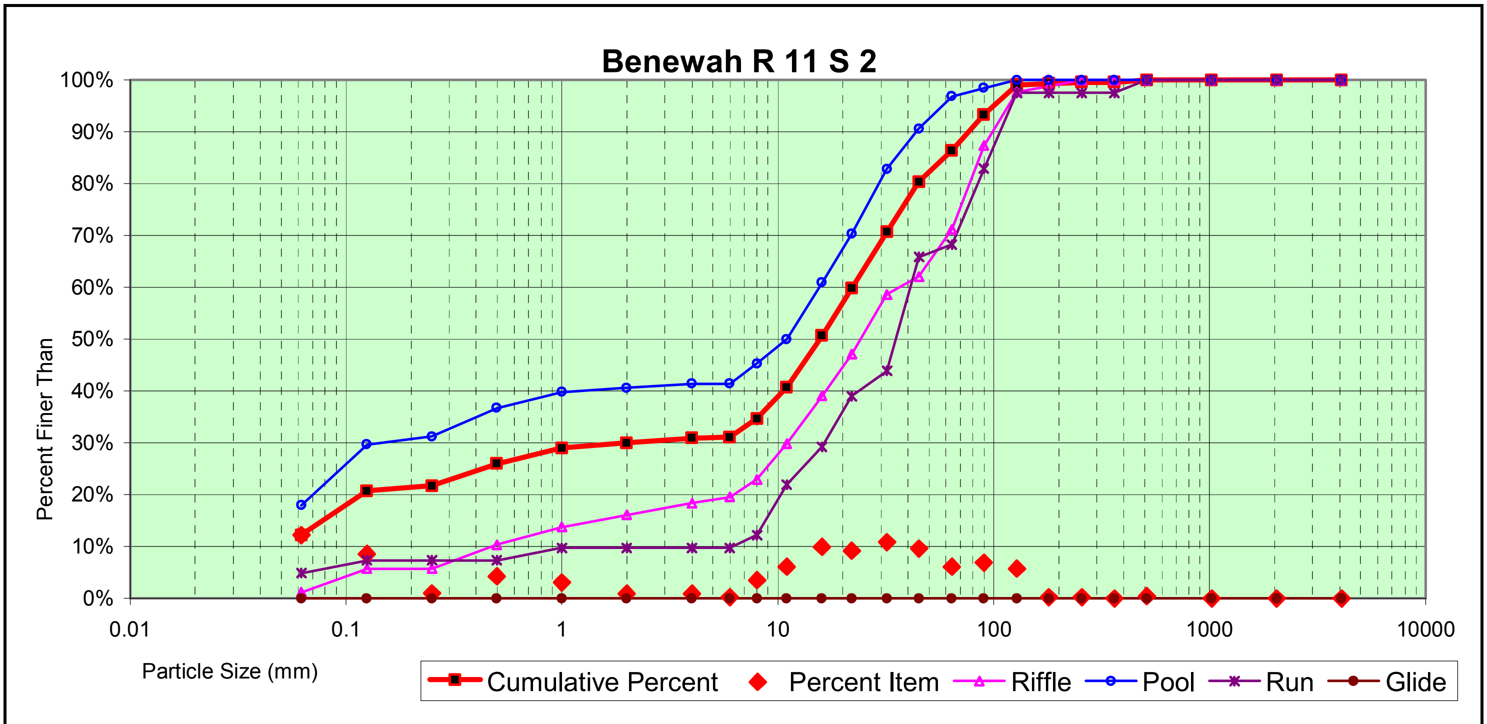


	Size percent less than (mm)					Percent by substrate type			
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
20.8	43.6	68.3	155.3	220.1	0%	0%	47%	53%	0%	0%

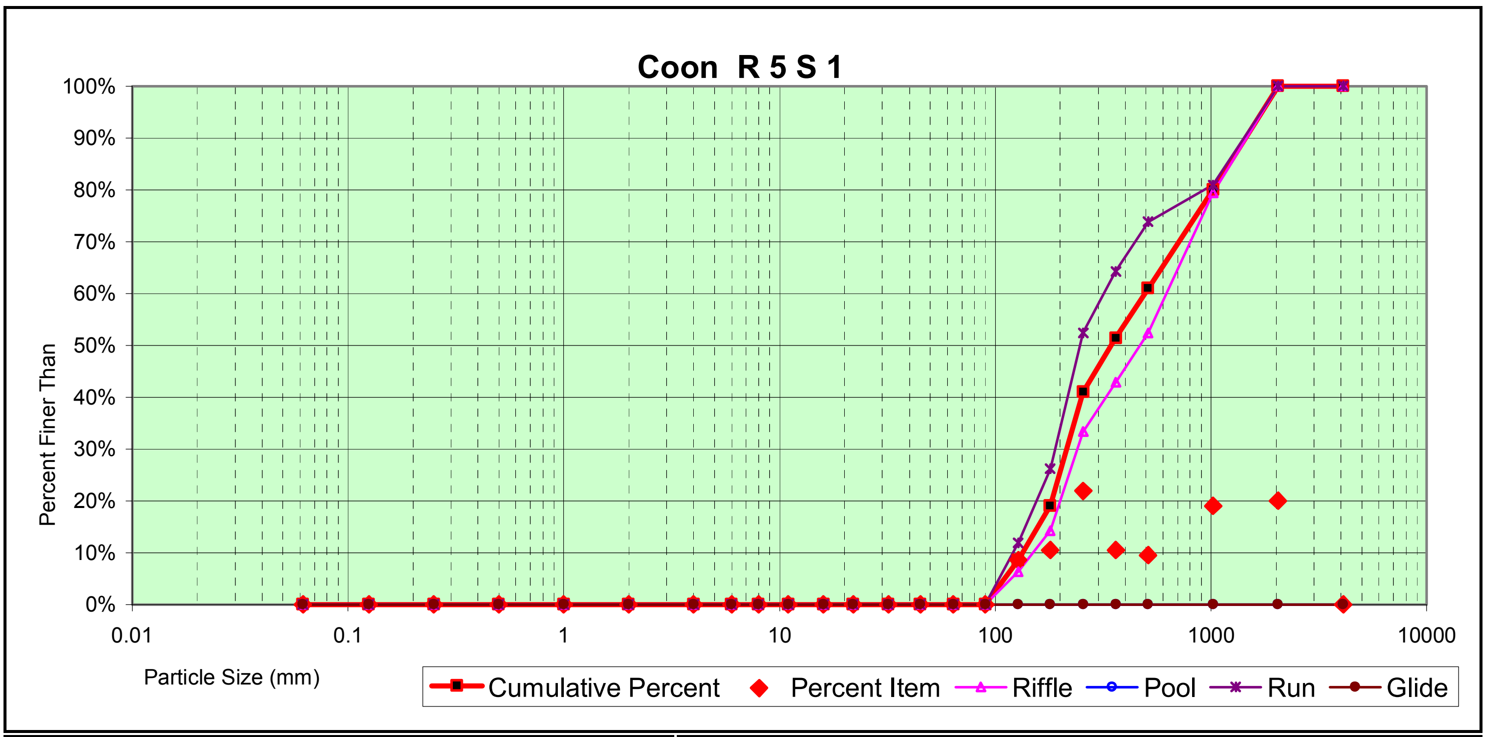
* NOTE: Preliminary estimate of percentage of habitat types (riffle, pool, run) used for calculation of "Size percent less" based on percent of pebble counts for that type.



	Size percent less than (mm)					Percent by substrate type				
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
17.0	26.0	33.2	55.8	78.6	3%	0%	87%	9%	0%	0%

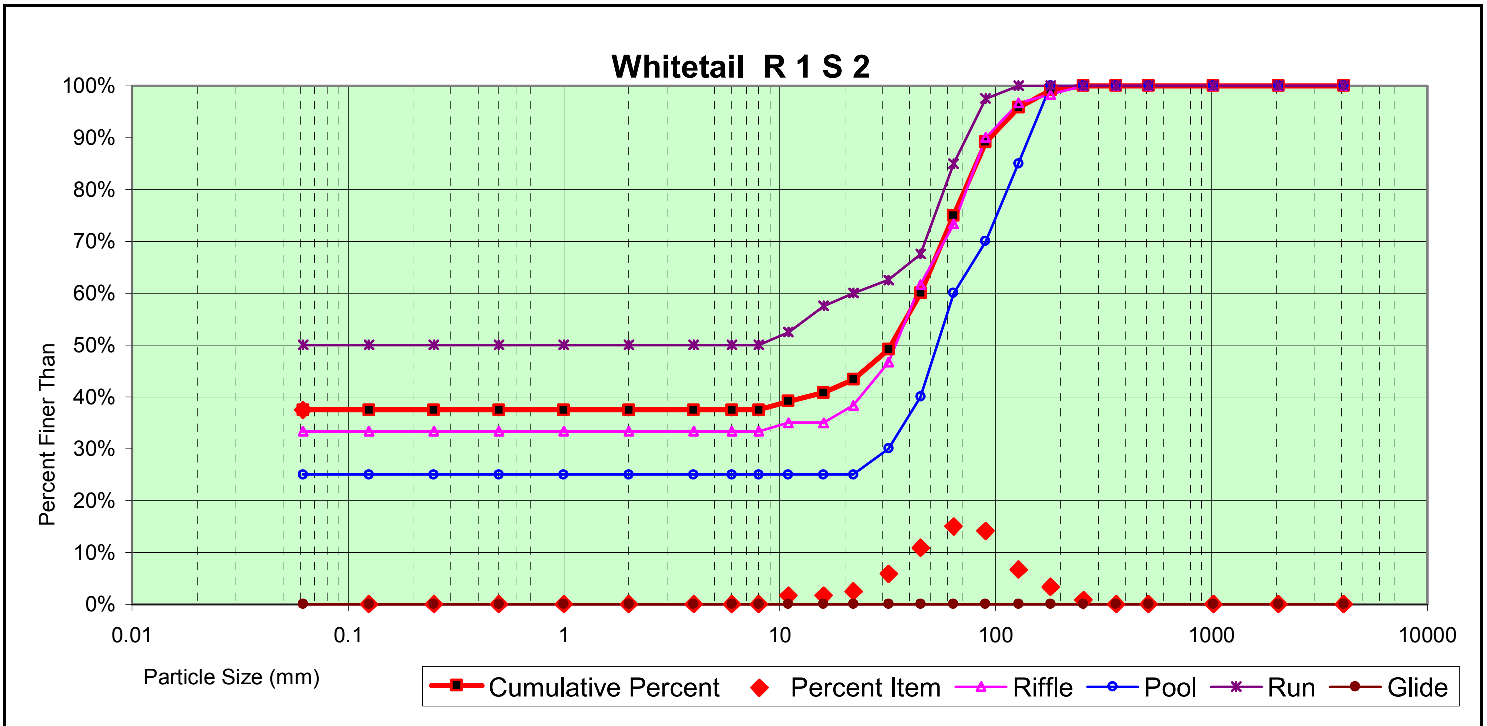


	Size percent less than (mm)					Percent by substrate type				
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
0.1	8.1	15.6	55.6	99.7	12%	18%	56%	13%	0%	0%



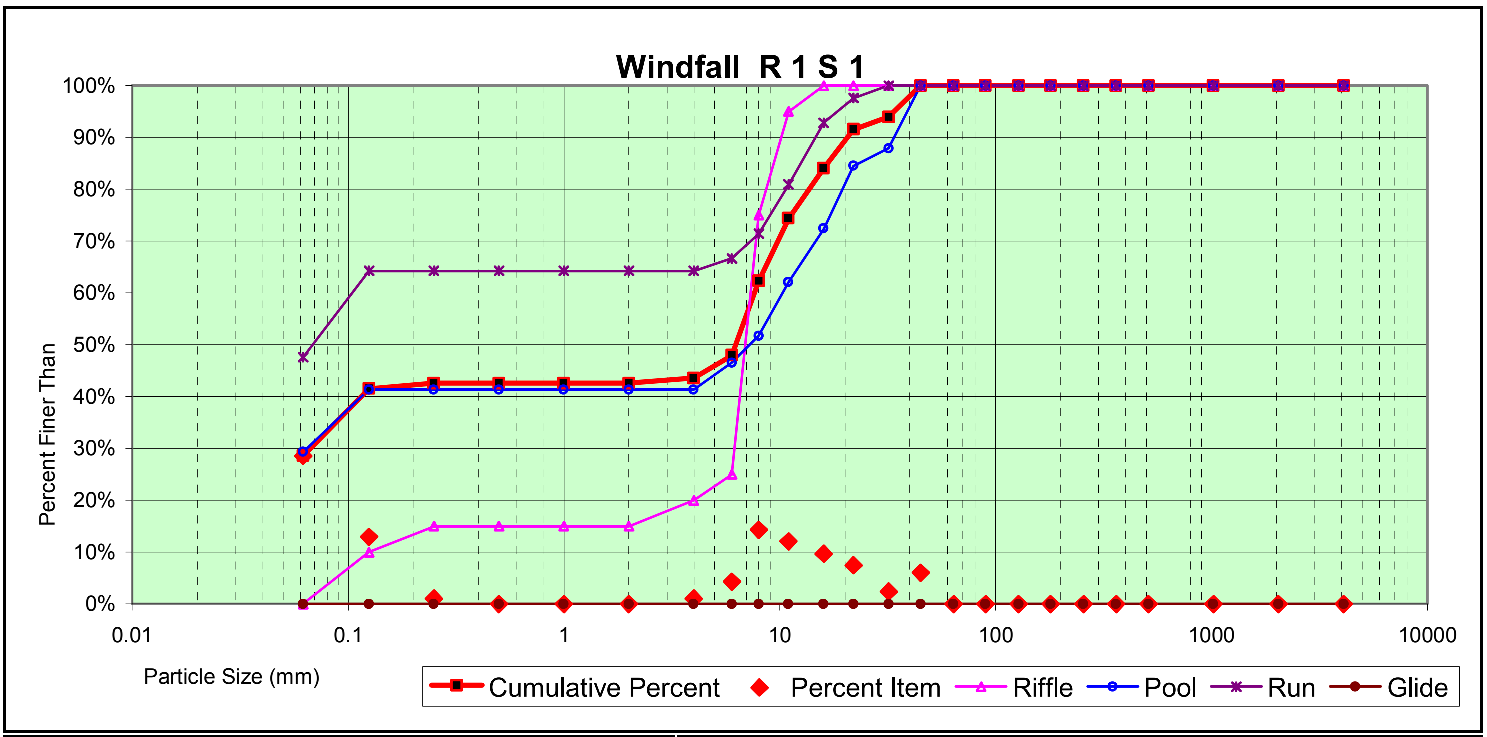
	Size percent less than (mm)					Percent by substrate type				
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
163.0	232.6	345.2	1176.2	1722.1	0%	0%	0%	36%	52%	12%

* NOTE: Preliminary estimate of percentage of habitat types (riffle, pool, run) used for calculation of "Size percent less" based on percent of pebble counts for that type.

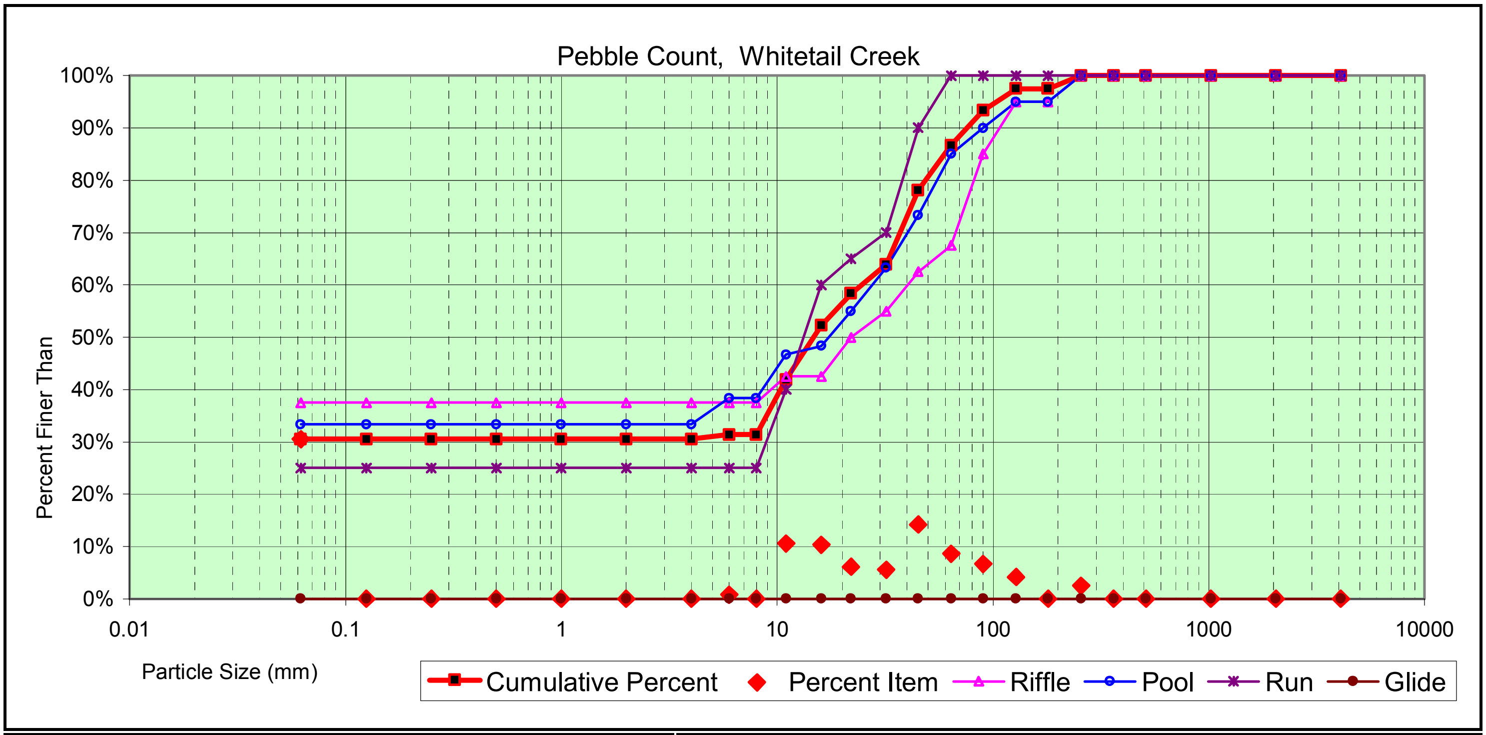


	Size percent less than (mm)					Percent by substrate type				
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
#N/A	#N/A	32.9	79.5	122.5	37%	0%	38%	25%	0%	0%

* NOTE: Preliminary estimate of percentage of habitat types (riffle, pool, run) used for calculation of "Size percent less" based on percent of pebble counts for that type.



	Size percent less than (mm)					Percent by substrate type				
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
#N/A	0.1	6.3	16.0	34.0	29%	14%	57%	0%	0%	0%



	Size percent less than (mm)				Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
#N/A	8.9	14.7	57.3	103.4	31%	0%	56%	13%	0%	0%

* NOTE: Preliminary estimate of percentage of habitat types (riffle, pool, run) used for calculation of "Size percent less" based on percent of pebble counts for that type.

Coeur d'Alene Tribe, Stream Canopy Cover Data, 2002

SITE: Benewah, Reach 1 Site 1 page 1

LOCATION	Densiometer readings Left Bank	Center Up	Center Down	Right Bank	Density (%)	Adjusted Density*
TR 1	10	0	0	0	15.0	15.0
TR 2	2	0	1	0	4.5	4.5
TR 3	17	0	0	5	33.0	32.0
TR 4	17	3	4	5	43.5	42.5
TR 5	17	0	0	0	25.5	25.5
TR 6	0	10	0	17	40.5	39.5
			Average Adjusted Density for site =			**26.5**

* 1% deducted for scores between 30% and 65%, 2% deducted from scores over 66%

SITE: Benewah, Reach 2 Site 1

LOCATION	Densiometer readings Left Bank	Center Up	Center Down	Right Bank	Density (%)	Adjusted Density*
TR 1	1	6	3	6	24.0	24.0
TR 2	5	0	0	0	7.5	7.5
TR 3	5	0	0	0	7.5	7.5
TR 4	13	0	2	17	48.0	48.0
TR 5	7	0	0	0	10.5	10.5
TR 6	13	0	0	7	30.0	29.0
			Average Adjusted Density for site =			**21.1**

SITE: Benewah, Reach 2 Site 2

LOCATION	Densiometer readings Left Bank	Center Up	Center Down	Right Bank	Density (%)	Adjusted Density*
TR 1	4	6	2	12	36.0	35.0
TR 2	5	2	2	9	27.0	27.0
TR 3	9	1	3	11	36.0	35.0
TR 4	4	0	0	17	31.5	30.5
TR 5	12	5	5	17	58.5	57.5
TR 6	17	12	12	12	79.5	77.5
			Average Adjusted Density for site =			**43.8**

SITE: Benewah, Reach 3 Site 1

LOCATION	Densiometer readings Left Bank	Center Up	Center Down	Right Bank	Density (%)	Adjusted Density*
TR 1	4	6	1	16	40.5	39.5
TR 2	0	0	0	15	22.5	22.5
TR 3	1	0	0	3	6.0	6.0
TR 4	1	0	0	4	7.5	7.5
TR 5	3	8	4	16	46.5	45.5
TR 6	0	0	0	17	25.5	25.5
			Average Adjusted Density for site =			**24.4**

SITE: Benewah, Reach 3 Site 2

LOCATION	Left Bank	Center Up	Center Down	Right Bank	Density (%)	Adjusted Density*
	Densiometer readings					
TR 1	7	4	0	0	16.5	16.5
TR 2	0	0	0	0	0.0	0.0
TR 3	0	0	0	0	0.0	0.0
TR 4	3	0	0	0	4.5	4.5
TR 5	6	3	3	0	18.0	18.0
TR 6	0		0	2	3.0	3.0
Average Adjusted Density for site =						**7.0**

SITE: Benewah, Reach 4 Site 1

LOCATION	Left Bank	Center Up	Center Down	Right Bank	Density (%)	Adjusted Density*
	Densiometer readings					
TR 1	17	7	3	10	55.5	54.5
TR 2	13	16	14	16	88.5	86.5
TR 3	2	8	3	15	42.0	41.0
TR 4	3	11	3	17	51.0	50.0
TR 5	8	7	15	16	69.0	67.0
TR 6	8	5	7	3	34.5	33.5
Average Adjusted Density for site =						**55.4**

SITE: Benewah, Reach 4 Site 2

LOCATION	Left Bank	Center Up	Center Down	Right Bank	Density (%)	Adjusted Density*
	Densiometer readings					
TR 1	17	2	1	17	55.5	54.5
TR 2	7	0	0	17	36.0	35.0
TR 3	4	11	8	4	40.5	39.5
TR 4	17	5	8	4	51.0	50.0
TR 5	3	5	7	5	30.0	29.0
TR 6	15	16	6	17	81.0	79.0
Average Adjusted Density for site =						**47.8**

SITE: Benewah, Reach 8 Site 1

LOCATION	Left Bank	Center Up	Center Down	Right Bank	Density (%)	Adjusted Density*
	Densiometer readings					
nd	17	1	2	0	30.0	29.0
nd	0	0	0	0	0.0	0.0
nd	0	0	0	0	0.0	0.0
nd	3	1	1	0	7.5	7.5
nd	7	0	0	6	19.5	19.5
nd	3	0	0	0	4.5	4.5
Average Adjusted Density for site =						**10.1**

SITE: Benewah, reach 8 Site 2 page 3

Densiometer readings

LOCATION	Left Bank	Center Up	Center Down	Right Bank	Density (%)	Adjusted Density*
TR 1	0	0	1	2	4.5	4.5
TR 2	0	0	0	0	0.0	0.0
TR 3	0	0	0	0	0.0	0.0
TR 4	0	0	0	0	0.0	0.0
TR 5	17	4	0	0	31.5	30.5
TR 6		17	3	2	11.0	11.0
Average Adjusted Density for site =						**7.7**

SITE: Benewah, Reach 9 Site 1

Densiometer readings

LOCATION	Left Bank	Center Up	Center Down	Right Bank	Density (%)	Adjusted Density*
TR 1	0	0	0	0	0.0	0.0
TR 2	17	15.0	7	15	81.0	79.0
TR 3	14	0	0	0	21.0	21.0
TR 4	8	1	1	14	36.0	35.0
TR 5	15	0	3	6	36.0	35.0
TR 6	0	0	0	6	11.0	11.0
Average Adjusted Density for site =						**30.2**

SITE: Benewah, Reach 9 Site 2

Densiometer readings

LOCATION	Left Bank	Center Up	Center Down	Right Bank	Density (%)	Adjusted Density*
TR 1	4	0	0	0	6.0	6.0
TR 2	17	0	1	15	49.5	48.5
TR 3	7	0	0	0	10.5	10.5
TR 4	0	3	0	0	4.5	1.5
TR 5	17	0	0	13	45.0	44.0
TR 6	7	3	6	0	24.0	24.0
Average Adjusted Density for site =						**22.4**

SITE: Benewah, Reach 10 Site 1

Densiometer readings

LOCATION	Left Bank	Center Up	Center Down	Right Bank	Density (%)	Adjusted Density*
TR 1	4	0	0	6	15.0	15.0
TR 2	0	3	6	8	25.5	25.5
TR 3	0	2	2	10	21.0	21.0
TR 4	6	3	1	0	15.0	15.0
TR 5	0	0	0	0	0.0	0.0
TR 6	17	2	8	0	40.5	39.5
Average Adjusted Density for site =						**19.3**

SITE: Benewah, Reach 10 Site 2

	Densiometer readings					
LOCATION	Left Bank	Center Up	Center Down	Right Bank	Density (%)	Adjusted Density*
TR 1	17	17	17	0	76.5	74.5
TR 2	9	0	0	0	13.5	13.5
TR 3	17	8	17	4	69.0	67.0
TR 4	17	7	8	0	48.0	47.0
TR 5	0	0	0	0	0.0	0.0
TR 6	0	0	0	0	0.0	0.0
			Average Adjusted Density for site =			**33.7**

SITE: Benewah, Reach 10 Site 3

	Densiometer readings					
LOCATION	Left Bank	Center Up	Center Down	Right Bank	Density (%)	Adjusted Density*
TR 1	5	0	0	0	7.5	7.5
TR 2	2	3	14	2	31.5	30.5
TR 3	0	12	0	0	18.0	18.0
TR 4	0	0	0	0	0.0	0.0
TR 5	0	0	0	0	0.0	0.0
TR 6	17	1	2	10	45.0	44.0
			Average Adjusted Density for site =			**16.7**

SITE: Benewah, Reach 11 Site 1

	Densiometer readings					
LOCATION	Left Bank	Center Up	Center Down	Right Bank	Density (%)	Adjusted Density*
TR 1	7	5	4	4	30.0	29.0
TR 2	10	7	2	4	34.5	33.5
TR 3	3	2	0		7.5	7.5
TR 4	0	1	0	0	1.5	1.5
TR 5	0	3	0	0	4.5	4.5
TR 6	3	3	0	0	9.0	9.0
			Average Adjusted Density for site =			**14.2**

SITE: Benewah, Reach 11 Site 2

	Densiometer readings					
LOCATION	Left Bank	Center Up	Center Down	Right Bank	Density (%)	Adjusted Density*
TR 1	3	0	8	11	33.0	32.0
TR 2	0	2	1	17	30.0	29.0
TR 3	6	6	17	17	69.0	67.0
TR 4	0	0	0	0	0.0	0.0
TR 5	1	0	0	2	4.5	4.5
TR 6	3	0	2	0	7.5	7.5
			Average Adjusted Density for site =			**23.3**

SITE: Coon, Reach 5 Site 1

Densiometer readings

LOCATION	Left Bank	Center Up	Center Down	Right Bank	Density (%)	Adjusted Density*
TR 1	14	3	7	17	61.5	60.5
TR 2	11	0	0	17	42.0	41.0
TR 3	4	0	0	2	9.0	9.0
TR 4	0	0	0	8	12.0	12.0
TR 5	5	0	0	7	18.0	18.0
TR 6	7	7	0	17	46.5	45.5
Average Adjusted Density for site =						**31.0**

SITE: Whitetail, Reach 1 Site 2

Densiometer readings

LOCATION	Left Bank	Center Up	Center Down	Right Bank	Density (%)	Adjusted Density*
TR 1	17	17	17	17	102.0	100
TR 2	17	17	17	17	102.0	100
TR 3	17	17	17	17	102.0	100
TR 4	17	17	17	17	102.0	100
TR 5	17	17	17	17	102.0	100
TR 6	17	17	17	17	102.0	100
Average Adjusted Density for site =						**100.0**

SITE: Windfall, Reach 1 Site 1

Densiometer readings

LOCATION	Left Bank	Center Up	Center Down	Right Bank	Density (%)	Adjusted Density*
TR 1	17	15	15	12	88.5	86.5
TR 2	17	15	16	15	94.5	92.5
TR 3	2	2	0	0	6.0	6.0
TR 4	17	16	17	17	100.5	98.5
TR 5	1	0	6	2	13.5	13.5
TR 6	17	17	17	17	102.0	100
Average Adjusted Density for site =						**66.2**

SITE: Windfall, Reach 1 Site 2

Densiometer readings

LOCATION	Left Bank	Center Up	Center Down	Right Bank	Density (%)	Adjusted Density*
TR 1	17	17	17	17	102.0	100
TR 2	3	6	4	3	24.0	24
TR 3	17	17	17	17	102.0	100
TR 4	17	17	17	17	102.0	100
TR 5	16	15	13	14	87.0	85
TR 6	17	17	17	6	85.5	83.5
Average Adjusted Density for site =						**82.1**

SITE: Lake, Reach 8 Site 1 page 6

	Densiometer readings					
LOCATION	Left Bank	Center Up	Center Down	Right Bank	Density (%)	Adjusted Density*
TR 1	0	0	0	0	0.0	0
TR 2	0	0	0	0	0.0	0
TR 3	0	0	0	0	0.0	0
TR 4	0	0	0	0	0.0	0
TR 5	0	0	0	0	0.0	0
TR 6	0	0	0	0	0.0	0
	Average Adjusted Density for site =					**0.0**